ROADS AND STREETS

Design, Construction, Maintenance and Traffic Control

H. P. GILLETTE, *Editor*

Sand Asphalt Pavement in North Carolina Utilizes Local Materials

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***See the Road and Street Catalog & Data Book**

In addition to the advertising messages to be found in this issue of Roads and Streets on the pages as indicated above, condensed catalogs of those marked * as well as other specifications and construction data will be found in the Road and Street Catalog and Data Book, the 384 page annual reference guide for the highway industries, published by the Gillette Publishing Co.

ROADS AND STREETS

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Vol. LXXI *Chicago, August, 1931* *No. 8*

Ventura Highway Through the Oaks of Conje Grade in Southern California

California-Carolina Contrast

Definite Development Plan Adopted Only After Engineering Economic Survey

TIME taken to compare the methods of planning state highway developments in North Carolina and California will disclose to the investigator the meaning of the term "engineering economics" as applied to highway work. The West, like the East, the Middle West and the South is confronted with the public clamor for tax reduction and more all weather roads. The following abstract of an address by C. H. Purcell, California's state highway engineer, before the Western Association of State Highway Officials, describes a plan which should be compared with the method employed in North Carolina.

According to Mr. Purcell, the two most vital issues facing the highway engineer today are:

1. *The orderly addition of new roads to the state highway system.*
2. *Preventing diversion of state highway funds.*

Although paradoxical, the two usually go hand in hand in that anything but the orderly addition of justifiable mileage to a highway system is itself an unwarranted diversion of state highway funds. Highway revenues, although at present they seem large to the casual observer, are still very meager for their intended purpose. It should be borne in mind that these funds are raised for purpose of making a high yield investment in highways and that any diversion may be likened to killing the goose that lays the golden eggs.

Reasons for Study.—As highways are the natural arteries of economic development, it is inevitable that the average state highway system must be extended to keep pace with the state growth. Sometimes this means laying out and constructing entirely new routes and sometimes taking over local roads that have assumed state wide importance. As local problems are of paramount importance to the average community, it is only natural that local pressure will be a factor to contend with wherever extensions are contemplated or requested.

The growing demand for the extension of the state highway system is a problem that must be squarely met and thoroughly analyzed by the highway engineer to

the end that the state may receive the greatest possible yield from the available highway revenue.

This demand comes primarily from two sources:

1. The demand of the motorist for the generally higher type of construction and maintenance reflected in state administration.
2. The demand of local governmental bodies for relief from expense in connection with roads which they feel are of more than local importance.

The fundamental justice of many such demands is unquestionable. However, in California as in most other states, highway officials are facing the fact that present revenues will not permit indiscriminate additions to state highway mileage, at the same time admitting that many roads proposed for inclusion have as much or more justification as many parts of the present state highway system.

In 1929 California took a forward step in the solution of this problem when by legislative resolution the highway department was instructed to make a thorough and complete study of county roads or new routes qualifying as possible state highways and after the completion of this study to make definite recommendation for the inclusion of not to exceed 10 or 12 per cent additional mileage in the state highway system.

In order that the problem of adding new roads could be met through gradual expansion, without imposing an impossible burden on the designated state highway system, a comprehensive study included: the extent to which a lack of balance existed in the several sections of the state preventing a well ordered and unified system; the extent to which highways might be added without jeopardizing existing and future maintenance and construction funds; and information as to the cost of bringing the state highway system up to a stage where traffic would be adequately and economically served.

A thorough investigation was made by the division of highways of routings which might qualify under the provisions of the resolution. These routings were defined in the legislative resolution as: highways now carrying a large volume of state traffic, highways affording relief to heavy traffic on the present state highways, and highways serving as important interstate links. Complete data were gathered for description and characteristic and economic value of proposed roads. Value was based upon analysis of traffic which called for a traffic survey to determine volume, origin, and destination. The percentage of local and state traffic was ascertained.

Ten-Year Survey Made.—For discussing the effect of including additional mileage, an estimate was prepared of the cost of bringing the state highway system to a status where traffic thereon will be adequately served. It was based on a careful reconnaissance survey by engineers of the department assigned to this special work for two years. The estimates represent, as nearly as can be determined from present and indicated future volume and character of traffic, the amount which should be spent to render the highways satisfactory for traffic developing within the next ten years.

The probable state highway revenues for a ten year period were also compiled from available data on previous revenues, motor vehicle registration, average gasoline consumption, and increase in population.

Comparing these independently derived estimates of cost and revenue, accurate knowledge of the relation between the revenue available for state highway maintenance and development, and the actual costs of such maintenance and development during the next ten years was obtained. With this knowledge at hand, the state has reliable information as to what its state highway problem is and can plan its state highway development in an orderly manner, both in regard to improving the present state highway system as well as in adding additional roads to the system as conditions require and funds permit.

Without this knowledge any highway program is essentially nothing more than a gamble. With this knowledge the state is able to plan the improvement of a definite mileage at definite locations, knowing that the funds so expended will yield the highest return. In other words, this ten year plan is strictly a business proposition. In the early days of highway construction with meager funds and small mileage any highway improvement almost regardless of location paid such extremely high dividends that the state could suffer no loss. With the present magnitude of mileage and funds it is essential that highway expenditures be placed on a strictly business basis, which necessarily demands scientific and comparative analysis of the state's needs as a whole.

Definite Completion Date.—The facts brought out in the California study clearly indicated its value and the analysis of these facts brings assurance that continuance of the present program of progressive development with revenues now authorized will result by 1940 in bringing California primary state highways to a standard of alignment, grade, width, and surfacing equal to practical traffic demands. By then the primary system should reach for the first time in its history a status where current requirements for adequate traffic service will have been supplied. Beyond this point continued effort should be able to anticipate and keep pace with traffic needs.

Based on this study and in conformity with the mandate of the legislature, the highway department recommended the inclusion of a number of new routes as secondary state highways, the total being 804 miles.

The 1931 session of the legislature adopted this report on the orderly addition of roads and established as state highways the roads recommended therein. The legislature at this session also authorized the continuance of the policy of orderly additions to the state highway system, based on establishing traffic qualifications and engineering investigations and study, and approved the policy that all programs for highway expenditures be based on a state wide economic analysis of traffic conditions.

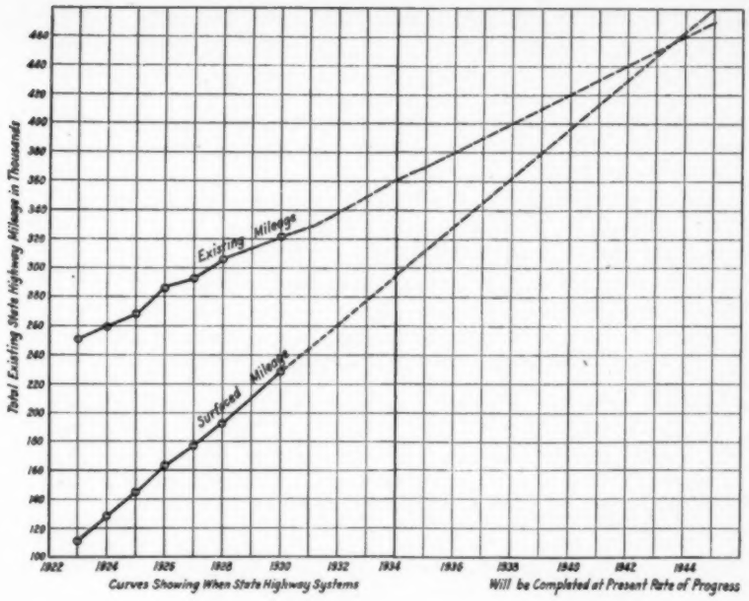
California is therefore assured that the expansion of her state highway system, as well as its construction and improvement, will be based on a development program looking at least ten years ahead and supported by engineering economic studies.

This assurance, however, depends on the steadfast application of available revenues to this single purpose. Due to the comparative magnitude of highways revenues, these funds will always be the target for continual attempts at diversion.

The education of the public and public officials to guard against such diversion is a subject worthy of the earnest attention of this association.

COST OF ENGINEERING.—An analysis of all state highway contracts completed in California between July, 1927, and April, 1930, showed the cost of preliminary surveys and preparation of plans to be 2.38 per cent, and the cost of construction engineering to be 5.35 per cent of the total state expenditures.

SUPER-Association *or* PERIOD PLAN?



By V. J. BROWN
Associate Editor

Highway Expenditures Offer Food for Thought

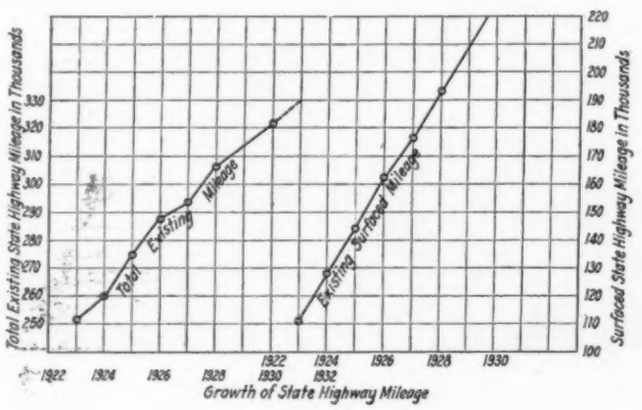
ARE we reaching the peak in total highway expenditures? Since 1928 the curve showing these annual expenditures has been increasing at a decreasing rate. While state highway expenditures have been mounting at a decreasing rate of increase, county and local road expenditures have actually decreased. In this field, the trend toward decreasing county expenditures occurred coincident with an increase in state highway expenditures. What is the cause behind this condition? Certain it is that motor vehicle and gas taxes have helped to swell the funds for the states. Whether or not this has been accomplished at the expense of counties and smaller governmental units is difficult to show. There is no doubt, however, that a portion of these funds should revert to the counties for expenditures on the secondary road systems.

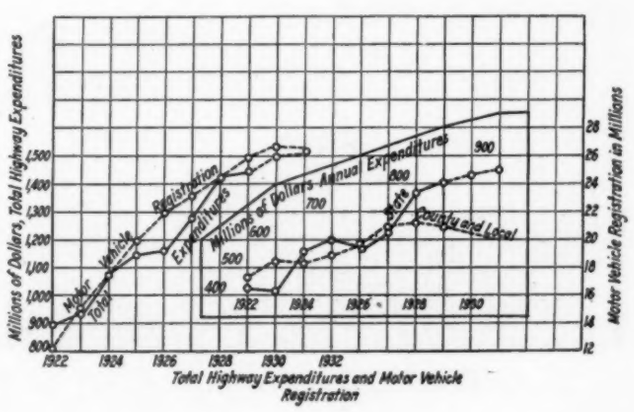
The primary road system has grown at the average rate of 10,800 miles per year. Why should not the states complete the construction of this system without increasing any further? If they continue in the future as they have in the past it will be 1944 before construction (reconstruction not considered) catches up with systems adopted. Since expenditures had to increase in like rate in the past they will likewise have to continue to increase proportionately in the future.

If we have reached a peak in expenditures, the states should adopt a plan for completion in a definite period of time. The people would then know what status changes occur and how much money to appropriate for highway construction on the primary routes and how much state aid to offer to the counties for secondary road construction. The taxpayer would know when to expect completion of the primary system and because of this knowledge be an enthusiastic road booster.

The two curves showing total existing road mileage and existing surfaced mileage indicate that no definite plans have been adopted for completion. Had the states adhered to plans existing in 1922 they would have had their systems about 90 per cent complete now. If, as suggested at the beginning of this article, highway expenditures have reached their peak, then either of two courses of action remains. Either plans must be made to complete primary systems now adopted, without adding more mileage, or a general publicity promotional agency must be established to goad the American people into the idea that more funds must be made available for expenditure.

The solution to the former suggestion would be easily accomplished with the present financial and operating set-up. Adoption of a definite period of time in each





state on which to budget existing income for completion of the primary systems would accomplish the result.

The solution to the latter suggestion is a super-association; an association for pure promotional propaganda formed by uniting the various agencies now at work in the highway field.

It might be argued that increased funds will come from an increase in the number of motor vehicle registrations. But consider the curve of registrations and it will be noted that this curve has flattened out. In other words, the automobile saturation point has been reached. Only the normal increase in population can be expected to increase the motor vehicle registration curve.

▼

Arizona Dedicates Beautiful Concrete Arch Bridge

THE longest and one of the most magnificent concrete bridges in the Southwest, carrying the traffic of three U. S. inter-state highways, has just been completed at Tempe over the Salt River about nine miles east of Phoenix, Ariz. An unusual feature of the Tempe bridge is the provision of eight rest towers at intervals along both sides of the bridge. These towers, each containing seats for several people beneath a concrete canopy, add greatly to its attractiveness.

The bridge carries traffic on U. S. Route 89, the only north and south highway through Arizona, and on Routes 60 and 80, both transcontinental highways crossing Arizona from east to west. A count of traffic over the old bridge on the same site showed a total of about 8000 vehicles every 24 hours. In designing the new bridge, provisions for future anticipated traffic of much greater volume were made.

Preliminary borings for the piers indicated that the site first chosen was unsuitable, as less than half of the length of the bridge was over shallow rock formation. A soft caliche extended to quite a depth under the remaining portion. However, a ridge of rock extending diagonally across the original line of the bridge was discovered, and the line was changed slightly to take advantage of a shallow rock foundation for the entire length. More than $100,000 is estimated to have been saved on foundations and roadways by changing the line from the original plan.

The concrete arch type of bridge was chosen in preference to steel plate girders. Only these two types were considered because the width of roadway limited the design to the deck type structure and because it was desired to keep the roadway on as low a level as possible, which limited the span length on account of available head room. One hundred and forty feet for concrete arches and one hundred feet for steel girders was the limit of span lengths possible.

Final plans called for an arch bridge of 10 concrete spans, each 140 feet long. The bridge measures 1577 feet in length. Spans are of the two-rib open-spandrel type. Each rib is 2 feet 9 inches thick by 9 feet wide at the crown and 7 feet 6 inches in the vertical plane at the pier. The roadway between curbs is 36 feet wide, allowing for four lanes of traffic. The total width between handrails is 46 feet; 5-foot walks for pedestrians being provided on each side.

To provide for convenience and safety in construction, spans were divided into groups of three, four, and three, and the groups separated by abutment piers. These abutment piers are of the same general design below the top of the arch as the intermediate piers except in size. The abutments are 15 feet in girth at the spring line of the arch while the intermediate piers are only 7½ feet. Two separate shafts on separate footings tied together with an arch tie-strut constitute the abutment piers.

In handling excavation, cofferdams of heavy sheet

New Structure Over Salt River at Tempe Is More Than ***1500*** *Feet Long*

steel piling were driven to rock, and sand and gravel were taken out with a crane. Concrete footings were anchored three feet into solid rock.

Abutment piers are surmounted by a sand box extending the entire length of the pier to give additional weight. The ends of these boxes are extended up above the roadway, forming the canopied rest towers previously mentioned.

Arizona's New Arch Bridge Opened Recently at Tempe

Concrete was mixed in a central mixing plant erected adjacent to a local gravel plant. An industrial railroad was used to haul mixed concrete from the plant to the job. A traveling gantry crane running on steel rails parallel to the bridge was used in depositing concrete. All concrete materials were proportioned by weight, strength being predetermined on the basis of the water-cement ratio. Concreting of the bridge deck was completed during May, 1931, and the last bit of concrete in the handrails was placed on June 3.

Handrails are of a distinctive design which harmonizes well with the rest of the structure. Over each intermediate pier, mounted upon a handrail block, is a concrete lighting post supporting a standard street lighting unit. Lighting units are also mounted on each side of the rest towers.

The roadway is a concrete slab supported on beams and columns above the two ribs.

The structure was designed by the Arizonia State Highway Department under the supervision of Ralph Hoffman, Bridge Engineer. The contract was awarded to the Lynch-Cannon Engineering Company of Los Angeles, Calif. Work on the contract was begun in March, 1930. The completed bridge was dedicated and opened to traffic on July 4, 1931.

Canopied Post Towers Beautify Prosaic Dead Load

Inventory Card System Checks Warehouse Stock

By A. H. Lind
Warehouse Superintendent

In the General Warehouse of the Arizona Highway Department at Phoenix a perpetual inventory card system is maintained covering all of the warehouse stocks at Phoenix.

This system is a visible card index, which at all times indicates the quantities of stocks on hand, the unit price of same, and the past disbursements, the files contain some ten thousand index cards, each covering a separate article.

A constant check is kept on the stock, as each item of stock is inventoried and the card is checked whenever it is necessary to reorder, in this manner when it is necessary to reorder any article for stock, an actual physical inventory on that item is made and the inventory is checked with the card, and if any discrepancy is found a further check is made of past disbursements, outstanding requisitions, etc., until the differences are located and the discrepancy eliminated.

Thus it will be seen that the warehouse stock balances are kept correct at all times, as far as it is possible for us to do so. This department is operated as any private business and attention to all details are always given that a correct and proper accounting can be made for all supplies received and disbursed.—*Arizona Highways.*

CALIFORNIA HIGHWAY MAINTENANCE FORCES.—The following table from the 7th biennial report of the ways of the Department of Public Works of the state Division of Highways of California shows the extent of the working field force on maintenance and the average mileage assigned to each superintendent and foreman. The list of superintendents and of foremen comprises the regular organization. The number of others employed includes several extra large gangs engaged on seasonal work.

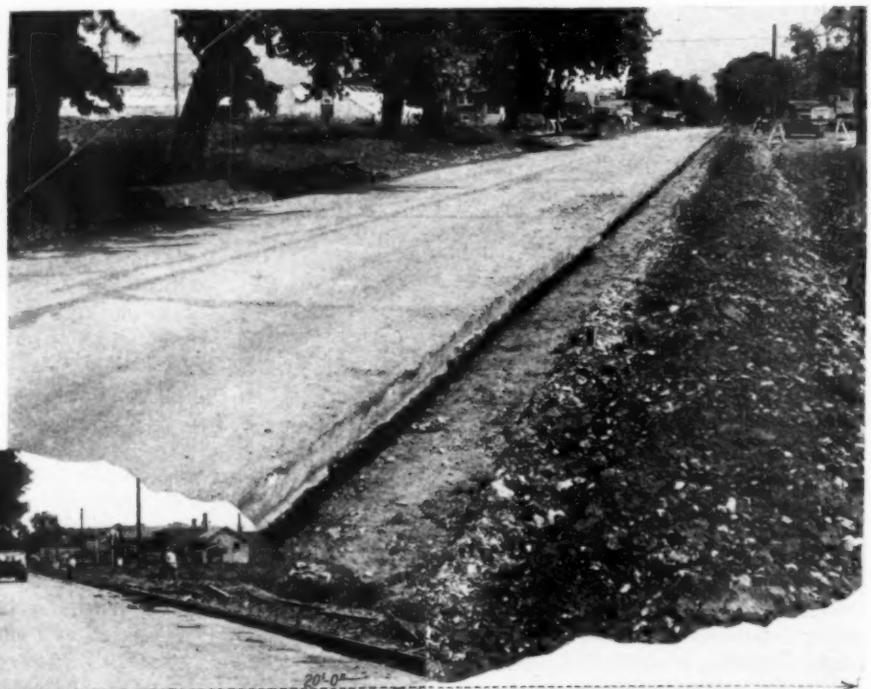
District Organization as of July, 1930

District	Number of superintendents	Average miles assigned each superintendent	Number of foremen	Average miles assigned each foreman	Number of other employees
I	4	128	20	25	349
II	4	99	32	22	491
III	6	144	26	33	252
IV	4	163	31	21	344
V	3	163	15	33	102
VI	3	206	19	32	263
VII	.	...	19	28	179
VIII	5	163	28	29	267
IX	1	...	12	36	85
X	6	123	13	56	217
Totals	39	142	215	30	2,549

PROPOSAL TO UNIFY LAWS ON FRENCH HIGHWAYS.—The Ministers of Public Works and Interior recently arranged for the introduction of a bill to unify the various laws regulating highways in France.

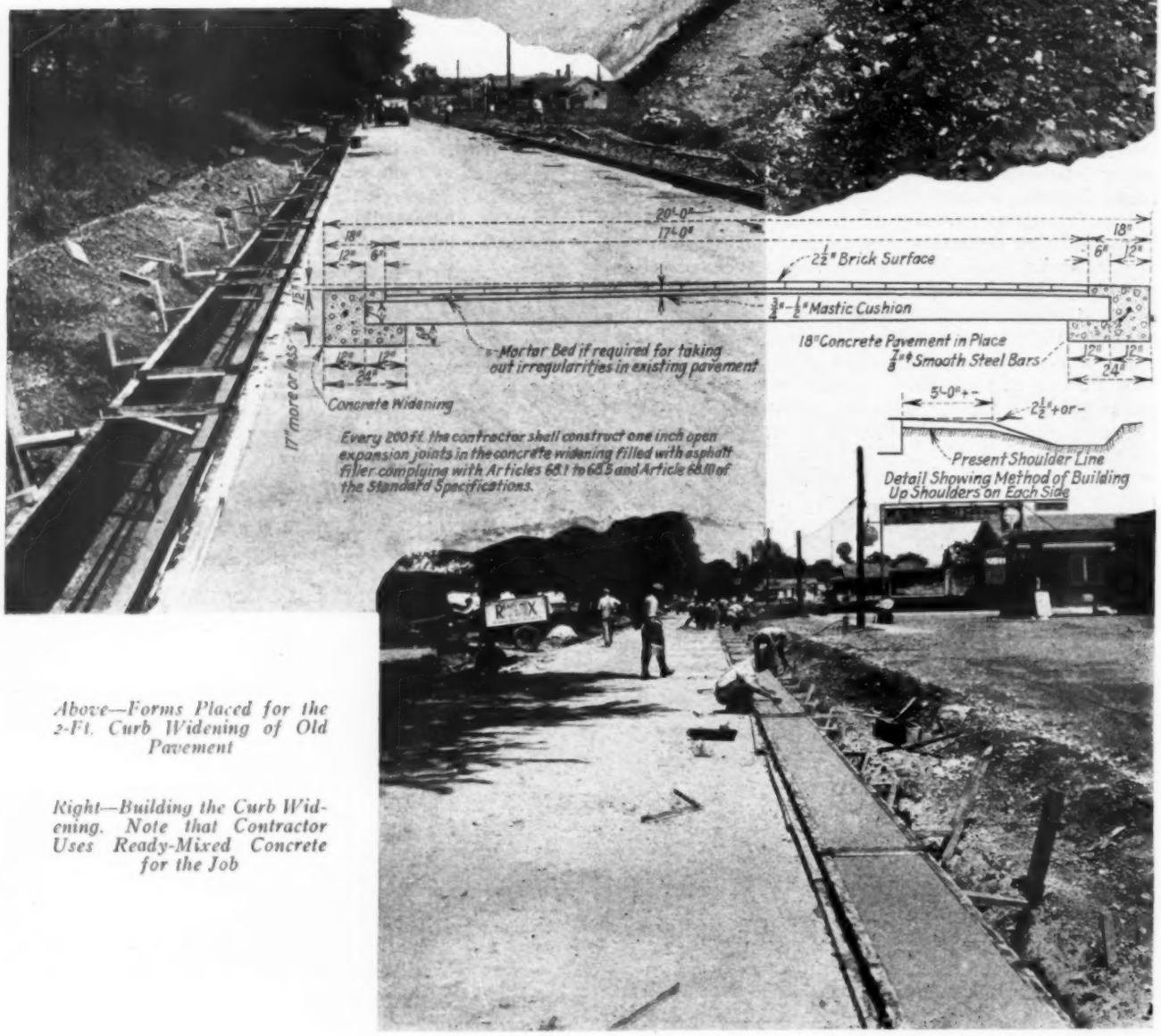
BRICK RESURFACING

Specifications on the mastic permit the use of either cut-back tar or cut-back asphalt (5 to 8%) with sand



Right — Excavation at Edge Extending 6 In. Below the Base for a Distance of 12 In. Under the Old Concrete Pavement

Inset—Typical Section of Brick Resurfacing in Illinois

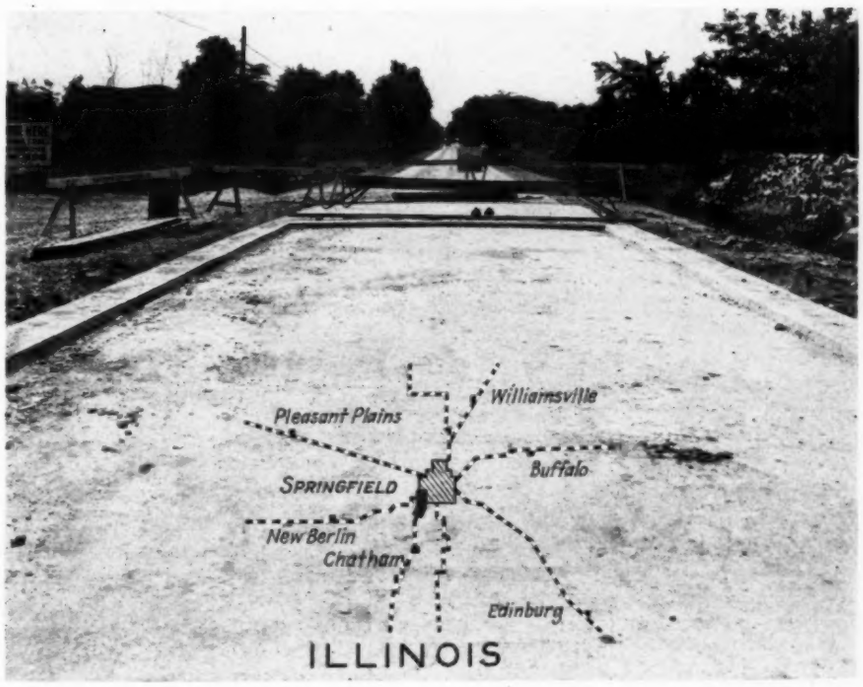


Above—Forms Placed for the 2-Ft. Curb Widening of Old Pavement

Right—Building the Curb Widening. Note that Contractor Uses Ready-Mixed Concrete for the Job

RECLAIMS WORN CONCRETE PAVEMENT

Old Rough Pavement Salvaged and Widened. Several Jobs of This Character Are Under Construction in Illinois



Pictures by: C. M. Hathaway, Engineer of Construction, Illinois Highway Department

BID PRICES

	QUANTITY	UNIT	AMOUNT
SANGAMON COUNTY, ILL., *Sec. D-R-S Route 4* *18-ft. original concrete pavement*			
Portland Cement Concrete Pavement (adjusting approach from old slab to new level of resurfacing)	111 Sq. Yds.	$1.65	$ 183.15
Brick Wearing Surface Including Mastic Cushion and Filler	6,156 Sq. Yds.	1.50	9,234.00
Mortar Bed	170 Cu. Yds.	7.25	1,232.50
Removing Existing Concrete Pavement	100 Sq. Yds.	1.00	100.00
Portland Cement Concrete (widening)	589 Cu. Yds.	9.80	5,772.20
TOTAL			$16,521.95

LOW BIDDER (5 bids received):
Sangamo Construction Company, Springfield, Illinois.

Above—Completed Curb Widening on the Job South Out of Springfield on Route 4

Left—The Completed Brick Resurfacing Presents Excellent Driving Surface

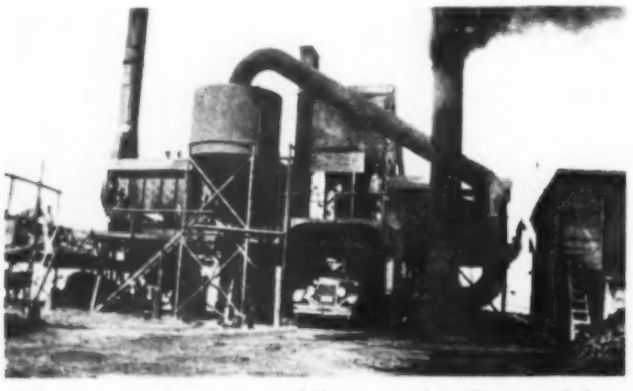
North Carolina Sand-Asphalt Paving Methods

By W. E. Hawkins
Construction Engineer, North Carolina Highway Department

IN the geological formation of the eastern part of North Carolina there are no stone or gravel deposits available. Topsoil, sand-clay, and bank-gravel are of such inferior quality that they are unsuitable for surfacing purposes. This section of the state has a limited population, spread over a large area, and many miles of roads connecting the small towns and communities.

The problem of any state having a large road building program is the difficulty experienced in obtaining an adequate supply of materials that will be satisfactory for construction purposes. Some states are fortunate in having natural deposits of suitable material located in many sections of their boundaries, while others have a limited supply which must serve the requirements for the entire state.

When North Carolina's road building program was inaugurated in 1921 this situation confronted the state highway commission. Funds available for construction purposes were very limited in these undeveloped sections, and to consider the building of a hard surface pavement would have been unwise. The excessive cost of the transportation of materials made the construction of this type prohibitive; likewise the volume of traffic did not justify a very expensive road.



Sand Asphalt Surface Mixtures Are Prepared in Standard Asphalt Plants

Along the eastern coast of the state, and for quite a distance inland, there are vast areas of sand. The problem, therefore, was to develop some type of pavement in which this local material could be utilized. In the late spring of 1922 experiments were conducted with mixtures of local sand and asphalt, and the results were so satisfactory that a continuation of this type of construction was warranted. The subsequent developments were such that during each year since the inauguration of this type of construction additional mileage has been constructed in sections of the state wherever local sand was available and subgrade conditions were suitable for this type of pavement.

Trucks Dump Loads onto Large Iron Plate from Which Mixture Is Shoveled into Place

In the contemplated construction of a sand asphalt project the primary investigation should be to ascertain whether or not suitable sand is available on the proposed work. The sand should consist of clean, hard, durable grains, free from clay, loam and other foreign matter. The gradings of the sand used on several recent projects were as follows:

	Proj. 3831	Proj. 3200	Proj. 3680
Retained on			
40 mesh sieve	20.4%	41.6%	25.0%
80 mesh sieve	38.8%	35.3%	45.6%
200 mesh sieve	35.6%	21.1%	24.8%
Passing 200	5.2%	2.0%	4.6%

It is essential that uniform gradings be maintained between the 40 and 200 mesh, as this will permit the utilization of a finer sand which can be used in this type of work.

The most satisfactory sand is one which closely approximates the grading used in sheet asphalt. Sand of this quality is very rarely available, and therefore it is necessary that care be exercised in balancing the proposed mix. This is accomplished by carefully determining the percentage of voids and establishing a formula in the laboratory which will properly fill the voids. By this method it has been found that sands unsuitable for sheet asphalt, due to wide variation from standard grading, can be used satisfactorily in sand asphalt when none is available.

The character and preparation of the subgrade is a very important factor in the construction of sand asphalt. In the early stages of this work it was deemed expedient that the subgrade be loose sand, but in later years it was found that a sand-clay subgrade, and in some cases a grade with a high percentage of clay, would make a suitable foundation if proper drainage was provided. The subgrade should be uniformly and firmly compacted, and brought to a firm, unyielding surface before any hot mix is placed thereon.

All unsuitable material encountered in the subgrade, such as excessive clay, vegetable matter, and detrimental soil, should be excavated and replaced with a satisfactory material that will become firm and compact.

After the completion of rough grading, timber forms are firmly set to line and grade. These forms are 2 in. by 8 in., long or short leaf pine, cypress, or other sat-

isfactory lumber, 10 to 15 ft. in length. The forms are securely staked and left in place after the pavement is completed. Following the form setting a small gang of men prepares the subgrade and completes the fine grading.

The base course mixture composed of 7½ to 8 per cent asphalt, penetration 50-60, and 92 1/3 to 92 per cent sand, is prepared at the plant, and delivered to the road in trucks at a temperature from 300 to 350 degrees Fahrenheit. This mixture is dumped upon a sheet metal dump board and shoveled into place on the subgrade. The hot mix is then struck off by a finishing machine to the proper shape and section, and after the material has cooled sufficiently the base course is rolled with a 8 to 10-ton tandem roller until the material is thoroughly compacted; the rolling starting longitudinally at the sides and gradually proceeding toward the center of the pavement. The base surface should be smooth and all irregularities patched before final rolling. From one to two days run of base course is permitted which is followed by the placing of the surface course. A squeegee coat of hot asphalt, penetration 50-60, is spread on the base course prior to the laying of the surface course. The asphalt is heated in a kettle to a temperature of from 300 to 350 degrees Fahrenheit and applied at the rate of 1/12 to 1/16 gal. per sq. yd. This squeegee coat is absolutely essential in order to insure a proper bond between the base and surface courses.

The surface course mix of 10 to 10½ per cent asphalt, 8 to 12 per cent filler dust, 82 to 79½ per cent sand, is delivered to the road, spread, and struck off by a finishing machine to the proper shape. The same weight roller is used, as on the base, the rolling being done longitudinally, followed by diagonal rolling in two directions.

The base course is laid to a compacted depth of 3 in., while the surface course is 2 in. in depth. The finished surface of both courses is checked with a 10-ft. straightedge during rolling operations, and repairs made where necesary in order that the final surface will be smooth and uniform. Previous to the final rolling of the wearing surface and while the pavement is still warm, a light coating of limestone dust or Portland cement is swept over the surface and the rolling continued until the surface course is thoroughly compacted.

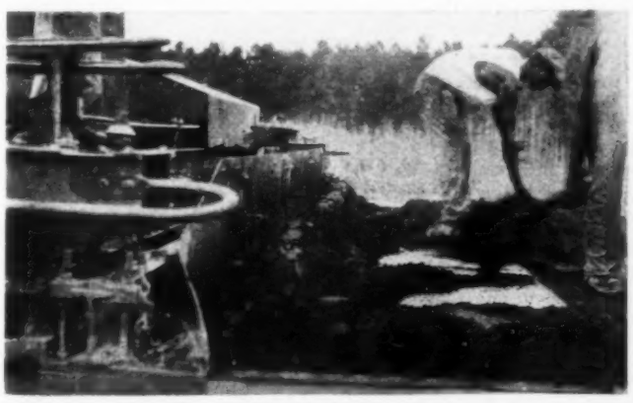
The density of the base course averages from 1.80 to 1.95, while the top course averages from 1.95 to 2.10. These average densities are the results of projects that have been constructed in recent years.

The asphalt mix is controlled on each project very accurately by a field laboratory in charge of an inspector. In addition samples of each day's work are forwarded to the laboratory in Raleigh and checked for A.C. content, sand gradings, and density. Should there be any distinct variation between the results of the samples and the daily reports of the inspector, an investigation is made at once. The construction details on the road are controlled by a roadway inspector. Daily reports are made by both inspectors as to the progress of the work.

First Rolling Is Done with 8-ton Tandem Roller

The plants used in this type of construction are similar to plants used on other asphalt work except in the size of the cylinders or drums in which the sand is heated and dried. The size and design of the heating drum is an important factor in the output of the plant.

We have constructed many projects on which the plant set-up was adjacent to the railroad. In these cases the plant is located near the sand pit, and shipments of asphalt and filler dust are unloaded on the plant siding. The sand is transferred from the pit to the plant by means of a gas crane and a ¾-yd. clamshell bucket. On projects away from a railroad the plant is erected at the sand pit, and the asphalt is hauled in tanks on trucks or barrels, and the filler dust in sacks. In the construction of a project recently completed near Wilmington, N. C., the asphalt was hauled by trucks for a distance of 30 miles, while the filler dust required a 9-mile haul. Storage tanks equipped with heating coils are erected



Finishing Machine Strikes Off the Surface Preparatory to Initial Rolling

Squeegee Coat Seals the Base Course Before Top Surface Is Placed

at the plant so that a reserve supply of asphalt may be kept on hand.

In recent years sand asphalt pavements have been constructed 16 and 18 ft. in width, at a cost ranging from $1.12 to $1.34 per sq. yd. In consequence of this low cost construction, many sections of the state have had roads improved, the building of which would not have been possible had a higher type of construction been considered.

Changes and improvements have been made from year to year in the details of construction, which have been for the betterment of sand asphalt work. At present some consideration is being given to one course construction. Experiments have been made in depths from 3 in. to 5 in. compacted, but on account of difficulties experienced in rolling the mix with an 8 to 10-ton tandem, no conclusions have been reached until a 3 or 4-ton tandem has been tried out with pavements of various depths.

The maintenance of these pavements has consisted of surface repairs, filling cracks, and repairing defects in the sub-base, caused by improper drainage conditions. These imperfections developed in the pavements first constructed. In recent years changes have been made in the details of construction which have resulted in an improvement in sand asphalt.

In some cases the maintenance costs on sections of this pavement are exceedingly moderate. During 1924 there was constructed a 5 1/3-mile project of sand

Finished Sand Asphalt Road

asphalt, located between Aberdeen and Southern Pines. The traffic between these two points ranges from 800 to 1000 vehicles per day. The only repairs necessary to this pavement have been an occasional filling of the surface cracks. The pavement at present is in excellent condition, and is rendering satisfactory service. There are other similar sections which have required very little maintenance.

The width of pavement of the original projects started in the state in 1922 was 10 ft. A large portion of this mileage has been reconstructed by adding 3 ft. of sand asphalt base on each side, and the entire width of 16 ft. resurfaced. The 10-ft. width served traffic purposes for a period of years, but on account of the increase in the volume of traffic, it became necessary to widen the old pavement.

Other sections of original construction have been resurfaced by flush coating an application of bitumen and covering with ¼ in. to ¾ in. stone chips at 25 lb. per sq. yd. This method of repair was tried out as an experiment, and it has been very satisfactory.

If local sand is available in any community, subgrade

This North Carolina Pavement Made from Local Materials Can be Built for $1.12 to $1.34 per Sq. Yd.

conditions suitable, and the volume of traffic does not justify a high type expensive road, a sand asphalt pavement will be adequate to meet all future requirements. Since 1922 North Carolina has constructed approximately 500 miles of this type, and the results have been so satisfactory that the adoption of this type of construction has been more than justified.

Acknowledgment.—This paper was presented at the Ninth Asphalt Paving Conference.

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Cost of Operating Automobiles in North Dakota

The cost of operating automobiles owned by the state highway department of North Dakota averaged 6.07 ct. per mile in 1930. The Highway Bulletin of the department gives the following table showing the cost subdivided into three general headings, upkeep, operation and overhead:

	Cost per Mile	Cost per Mile
Labor—Garages	$0.0091	
Parts	.0072	
Miscellaneous and Accessories	.0052	
Storage	.0022	
Total Upkeep—1930		$0.0237
Gas	$0.0146	
Oil	.0026	
Tires	.0029	
Total Operating—1930		.0201
Salaries (Administrative)	$0.0050	
Miscellaneous (Includes License Int. at 6%, Chief Mech. Traveling Expense)	.0006	
Insurance (Fire and Theft)	.0002	
Depreciation—1930	.0111	
Total Overhead—1930		.0169
Grand Total		$0.0607

Professor Agg of Iowa State College, in his study of car operating costs, found that the average cost of operating light sixes and light fours on intermediate type roals; and figuring 11,000 miles per year as the distance traveled, was 6 2-100 ct. per mile. As some of the North Dakota cars are used on winter maintenance and earth grade construction and thus operate under severe traffic conditions, it would be expected that higher operating costs than average would be obtained.

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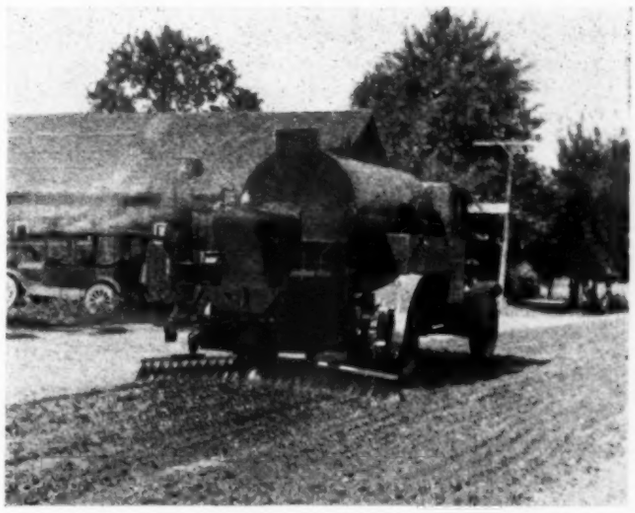
If you're going hiking in Delaware, take a lantern with you. The state legislature has decreed that pedestrians on state highways after dark must display lights. And just being lit up won't be an alibi.

—The Pennsylvania Road Builder.

Economic Features of Emulsified Asphalt Types

Various methods of construction described and illustrated

By C. L. McKesson*



Second Application on Retread Job

ROAD building is primarily an economic problem and engineering considerations cannot be properly approached without fully considering the basic requirements of traffic and the economic limits of permissible expenditures. In the earlier part of the past decade every energy was of necessity bent toward the rapid construction of trunk highways connecting the main centers of population and little thought given to the surfacing of the vast mileage of the secondary system. Expenditures of $50,000 to $100,000 per mile were common, almost usual, and with the almost unlimited funds available, problems of design were relatively simple. Slabs of pavement six to ten inches in thickness and twenty to forty feet in width were the common type and fortunately, due to the heavy traffic served on these major roads, the high costs involved were frequently justified. However, in the haste toward early completion of primary routes these expensive types were sometimes constructed where less expensive types would have served equally well.

Today, after twenty years of intensive highway building with billions of dollars of expenditures we have only three per cent of the highways paved with so called high types and one per cent more paved with intermediate types, ninety-six per cent yet to go. Seventy-eight per cent of the mileage is still unsurfaced earth.

It seems a fit time to pause and review the entire problem so that the relative importance of all factors entering into solution may be fully appreciated.

We have in the United States more than three million miles of rural roads. If it were possible to pave the entire federal highway system and all of the state highways not on the federal system with high priced, heavy pavements, more than nine-tenths of the total mileage would yet remain to be improved. There are still two million three hundred thousands of miles of earth roads. Recent estimates place the number of motor vehicles at twenty-six million five hundred thousand. On this basis we have less than nine (8.8) vehicles per mile of road. If full development is to be secured economy must be practiced.

Road Building Revenue.—Gasoline tax has become the most popular source of road revenue, the average tax being three and two-tenths cents per gallon. Based on five thousand miles of travel per year, per car, and five hundred gallons of gasoline purchased, the revenue per car would be $16.10 (actually it is $16.28 per car) and with 8.8 cars per mile of road, an average annual revenue from this source is $143.26 per mile of road.

Other taxes are being levied against automobiles, including license tax, personal property tax, etc., amounting to $18.72 per vehicle and bringing the total up to an average of $35.00 per auto per year.

The total annual revenue from automobiles if all applied to paving would provide an annual revenue of $2.555 per year per mile from each car using the road once daily. In other words, a mile of highway having a daily traffic of 100 vehicles would receive $255.50 as its proper apportionment of the total auto tax revenue.

*Member A. S. C. E.; Am. Conc. Inst.; Am. Assn. Asp. Technologists; A. S. T. M.; Director, Engineering & Research, American Bitumuls Company.

TABLE I—ANNUAL COST OF STANDARD PAVED SURFACES

In Relation to Revenue from Automobiles (Including Gas Tax $16.28, License Tax $18.72, Etc.). Total, $35 per Car

Average No. of Vehicles Per Day	Annual Revenue Per Mile	Type of Pavement	Cost of Pavement* (Base and Wearing Surf.)	Interest at 5 %	Resurfacing Years‡	Fund Per Year	Maintenance Per Year	Total Annual Cost	Profit (+) or Loss (—)
2,000	$5,110	24 ft. x 7 in. pavement	$25,000	$1,250	10	$1,000	$350	$2,600	+$2,510
1,000	2,555	20 ft. x 7 in. pavement	20,000	1,000	12	800	250	2,050	+ 505
500	1,277	18 ft. x 7 in. pavement	18,000	900	14	720	200	1,820	— 543
300	766	16 ft. x 7 in. pavement	16,000	800	15	640	200	1,640	— 774
200	511	16 ft. x 6 in. pavement	15,000	750	16	600	150	1,500	— 989
120†	316	16 ft. x 6 in. pavement	15,000	750	18	550	150	1,450	— 1,134
100	255	16 ft. x 6 in. pavement	15,000	750	20	500	100	1,350	— 1,095

*Cost of sub-base, grading, structures and right-of-way not included.
†Average traffic per day per mile of rural roads based on gas tax.
‡Years between resurfacing operations.

TABLE II—ANNUAL COST OF BITUMINOUS TREATED SURFACES

In Relation to Revenues from Automobiles (Including Gas Tax $16.28, License Tax $18.72, Etc.)

Aver. No. Vehicles per Day	Rev. Annual enue per Mile	Type of Surface	New Base and Wearing Surface Cost* Macadam Base	Bituminous Surfacing	Annual Cost Pavement Only (per Mile) 5% Interest	Renewal Fund Years†	Renewal Fund Per Year	Maintenance	Total Annual Cost	Profit(+) or Loss(—) on Revenue	Using Existing Macadam or Gravel as Base Total Cost (per Mile)	Total Annual Cost‡	Profit(+) or Loss(—) on Revenue	Annual Saving per Mile Over Paving Table No. 1
2,000	$5,110	24 ft. wide, 3 in. bit. top, 5 in. crushed stone	$7,000	$8,400	$750	5	$630	$350	$1,730	+$3,380	$8,400	$1,380	+$3,730	$1,220
1,000	2,555	20 ft. wide, 3 in. bit. top, 5 in. crushed stone	5,600	7,300	645	5	520	200	1,365	+ 1,190	7,300	1,085	+ 1,470	965
500	1,277	20 ft. wide, 2 in. top, 5 in. crushed stone	5,600	4,800	520	6	400	200	1,120	+ 157	4,800	840	+ 437	980
300	766	18 ft. wide, 1 in. armor coat, 5 in. crushed stone	5,000	3,000	400	7	300	150	850	— 84	3,000	600	+ 166	940
200	511	18 ft. wide, light bit. surface, 5 in. gravel	4,000	2,000	300	7	300	100	700	— 189	2,000	500	+ 11	1,000
120	316	18 ft. wide, light bit. surface, 5 in. gravel	4,000	2,000	300	8	225	100	625	— 309	2,000	425	— 109	1,025
100	255	16 ft. wide, light bit. surface 4 in. gravel	3,500	2,000	275	8	200	100	575	— 320	2,000	400	— 145	950

*Cost of sub-base, grading, structures and right-of-way not included.
†Years between bituminous treatments, charge to cover reconstruction.
‡Total annual cost is annual cost with base minus interest charge on base.

Table I has been prepared to give an approximate idea of how far this revenue goes toward paying the annual cost of the recognized minimum types of standard pavements. The construction and maintenance costs assumed in preparing this table are believed to be conservatively low considering averages throughout the country. This table indicates that each mile of twenty foot by seven inch pavement costing $20,000.00 must carry an average of nearly one thousand vehicles per day for the entire year in order to stay within its prorata of the gas tax and other auto revenue.

Fig. 1—Weston-Worcester (Mass.) 2½-in. Asphaltic Penetration Macadam Pavement on 4½-in. Macadam Base on Gravel Sub-Base. Constructed 1913-1914. Never Resurfaced. Photographed November, 1929

Many miles of paved highway have been constructed in the United States at a cost of $20,000.00 or more which do not average more than three hundred to five hundred vehicles per day throughout the year and these roads are using revenue belonging to other roads.

Seven years ago our most eminent road builder, Mr. Thomas H. McDonald, gave expression to the idea which has since gained almost universal recognition, saying, in substance—"The need is not for greater refinement in the standard methods of paving, but the development of cheaper types adequate for the traffic requirements of the vast mileage of secondary roads."

Bituminous Types and Their Economic Advantages.—Bituminous types make possible the construction of low cost roads which are economical to maintain and which meet the service demands of an exacting public.

Table II shows the relation of earnings to annual cost for various bituminous types which would be adequate for the traffic involved. While Table I shows the annual cost to be more than the tax collected from the autos using the road where traffic is less than 800 vehicles daily, Table II shows that properly designed bituminous types are self-supporting with a traffic of 200 vehicles per day with a handsome surplus of tax money left

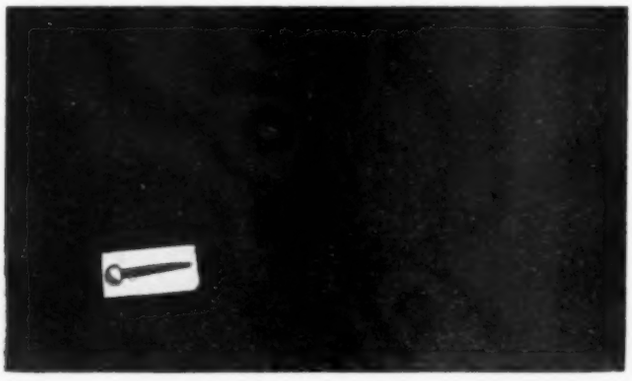


Fig. 2—Typical Non-Skid Surface; 3-in. Bituminous Penetration Pavement (Ridge Route in California, Between Los Angeles and Bakersfield)

when traffic is over 500 cars per day. Such a surplus means many more miles of road and that within reasonable time all autoists who are contributing revenue will secure proper highway service.

Asphaltic concrete types on asphaltic base and on cement concrete base have general recognition as being suitable for heavy duty service but we have sometimes lost sight of the marvelous service and low annual costs which have been secured from penetration types with proper gravel or macadam bases. Massachusetts, Rhode Island, Connecticut, Pennsylvania, and many other states have striking examples of this kind of work. Only one example will be cited to illustrate the point.

Fig. 1 shows a section of the Weston-Worcester

(Mass.) Highway constructed in 1913. After seventeen years of heavy duty (eight thousands to twenty thousand vehicles per day) this pavement is in good condition and is maintained at a cost of about $60.00 per mile per year. Analyzed on the basis used in Table I, this section would show an operating profit of $20,000 per mile or more per year including an annual allowance for resurfacing, which is not yet needed.

Bituminous Types for Light and Medium Traffic.—It is in the field of light and medium that bituminous types are indispensible. Cement concrete does not lend itself to thin surfaces and cannot be used over flexible bases.

Fig. 3—Shows Side View of 50-ft. Fill on Bernal Avenue, San Francisco; 5/8-in. Crushed Stone Base

Some of the outstanding economic advantages of bituminous treatments and surfaces are as follows:

1. They make possible the utilization of existing gravel or macadam bases.
2. They immediately stop the loss of road metal and in this saving alone soon repay their cost. (The loss of road metal frequently amounts to $700 to $1,500 per mile per year.)
3. They are easy and economical to maintain.
4. Variations in thickness from ¼ inch to as many inches as may be needed are possible with bituminous types.

Fig. 4—Bernal Avenue, San Francisco

5. They are perfectly adapted to stage construction, because of flexibility on new grades and that they may be built up gradually in thin layers.
6. They are easy to widen or thicken to meet increased traffic requirements.
7. Their initial low cost makes possible many more miles of construction of dustless, smooth riding pavement where funds are limited.
8. They reduce tire wear on metalled surfaces from 50 to 75 per cent.

Until recent years the tendency to slipperiness and corrugation was sometimes an objection to bituminous treatments but the increased skill in the use of bituminous binders and the development and use of emulsified asphalt for penetration and surface treatment work during recent years has now made possible the elimination of excesses of asphalt in such work and the construction of ideally non-skid surfaces.

Fig. 2 shows a typical non-skid surface after thirty months of heavy trucking and passenger traffic.

Fig. 5—2-in. Emulsified Asphalt on 4-in. Macadam Base, U. S. Route No. 101 Near San Ardo, California

Typical Examples of Economical Construction

The possibilities of the economical use of asphalt in meeting varied problems of road building will be illustrated by a few typical examples.

Stage Construction Over Yielding Foundation.—The city of San Francisco has been building a new system of arterial boulevards involving heavy cuts and fills.

Fig. 3 shows a side view of a fill made on one of these new boulevards. The fill was made by end dumping and much settlement was expected. The boulevard crosses many heavily travelled streets and immediate paving was necessary to care for the heavy traffic. As soon as the fill was completed it was covered with a layer, five to ten inches in thickness, of soft red crushed rock from a nearby hill and then surfaced with a 2½-in. emulsified asphalt penetration wearing surface.

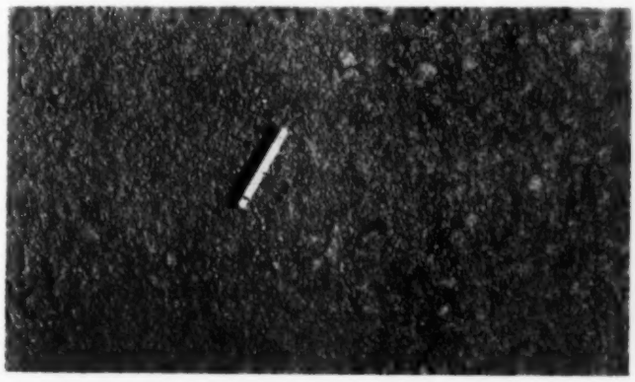


Fig. 6—Close-up View Showing Non-Skid Texture of Pavement Shown in Fig. 5 After 3 Years of Heavy Traffic Service

Fig. 4 shows the pavement after several months of pounding under traffic. The varying curb face and

crooked traffic lines show the settlement, which has not, however, appreciably damaged the pavement. The cost of this pavement was less than $1.00 per square yard for base and top and, when finally resurfaced and brought to correct grade, will still be less than one-half of the cost of adjoining pavement of standard type constructed on solid sub-base.

Four years ago the California highway department made line changes in their main Coast Highway and a surfacing was immediately necessary to carry traffic while fills were settling. A supposedly "temporary" pavement was constructed, consisting of a 4-in. macadam base and a 2-in. penetration top, using emulsified asphalt as a binder. The cost of this pavement was about half that of a standard type used on similar sections on good sub-base, yet after four years of use, all of the sections are in good condition with negligible maintenance cost. Some of the remarkable success on this section was probably due to the high grade crushed stone used in its construction.

Fig. 7—Kentucky Route No. 33 Near Carrollton. Cold Asphaltic "Retread"

Fig. 5 shows the pavement after forty months of use and Fig. 6 shows the non-skid texture yet remaining.

"Armorcoating" or "Retreading" Metalled Roads.—Perhaps one of the greatest fields for the economical construction of bituminous surfaces is in "Armorcoating" or "Retreading" roads which have sufficient metal to carry traffic loads but which are dusty, rough and expensive to maintain under traffic.

Fig. 8—U. S. Route No. 99 Near Oregon Line—1-in. Emulsified Asphalt "Armorcoat"

Two typical examples will be cited. On Kentucky Route No. 33 near Carrollton the existing surface was built from over sanded river gravel with little binding value and the road was rough and dusty. The "Retread" construction consisted of the addition of 1½ inches of crushed limestone, followed by scarifying to loosen old material about one inch. The new and old materials were mixed with emulsified asphalt and finally sealed with the same material, at a total cost, including the new limestone, emulsified asphalt, labor and equipment, of only $3,234.00 per mile.

On the Pacific Highway in California near the Oregon line the existing surfacing consisted of traffic bound crushed stone and gravel. Some sections had been surface treated with light road oil but traffic is fairly heavy (two thousand to four thousand vehicles per day). Early in 1930 a seventeen mile section from Yreka to Gazelle were given a 1-in. "Armorcoating," 20 feet in width, at an average cost of approximately $2,850 per mile. The crushed stone was spread mechanically and bladed and broomed into place and the emulsified asphalt applied with pressure distributors in three applications. The resulting roadway shown in Fig. 8 is smooth, uniform and non-skid.

Fig. 9—Le Conte Avenue, Berkeley, California. Cold Asphaltic Penetration Pavement

Reconstruction of Old Pavement.—Great economies are effected by "Armorcoating" or "Retreading" old and badly worn pavements.

Fig. 9 shows an old asphalt street in Berkeley, California, one year after resurfacing with an emulsified asphalt retread 1½ to 3 inches in thickness. The total cost for asphalt, crushed rock, and labor was only 6.4 cents per square foot. The pavement is on a 12 to 17 per cent grade and remains perfectly non-skid in texture.

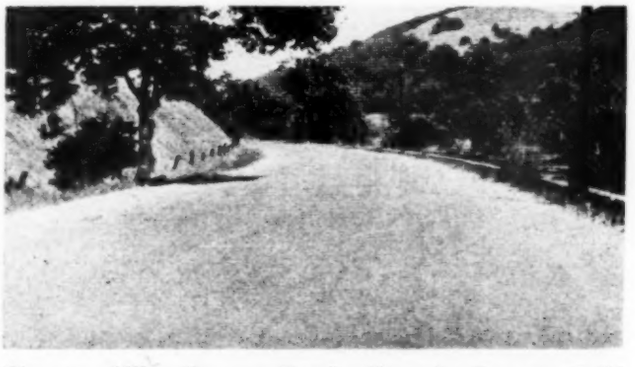
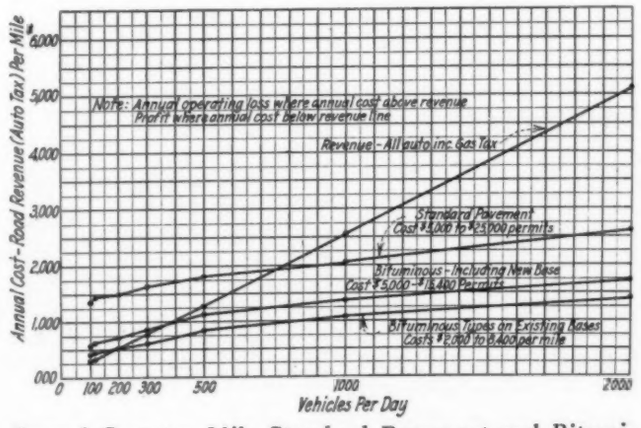


Fig. 10—Niles Canyon Road, Alameda County, Calif.

Salvaging of Gravel Roads.—The modern practice of efficient salvaging of a gravel road by using it as a base for a very light bituminous wearing surface finds an

outstanding example in the Niles Canyon job in Alameda County, California. This is a county road carrying two thousand or more vehicles daily and on Sundays and holidays several times this number. Early in 1927, realizing that blading, dragging and sprinkling were becoming unreasonably expensive, the county engineer, George Posey, constructed a double surface treatment consisting of two one-third gallon applications of emulsified asphalt to the swept roadway, each application covered with about twenty pounds per square yard of screenings, broomed and rolled. The total cost of the work, about



Annual Cost per Mile Standard Pavement and Bituminous Treatments in Relation to Road Revenue from Tables I and II

$1,800 per mile, was fully repaid by two years saving in maintenance and the durable asphaltic surface obtained after four years is being maintained at a cost of $100 per mile per year.

Fig. 10 shows a typical view after over two years of use.

This improvement analyzed for total annual cost, as in Tables I and II, would show a surplus over automobile revenue of $4,425.00 per mile per year after deducting for maintenance interest and providing for retreatment at five year intervals. Compared with a standard pavement in Table I it will be seen that the taxpayer is saving $2,000 per mile per year because of the selection of this economical type by his engineer instead of a hard surfaced type. This improvement corresponds in construction details with the one shown in Table II designed to carry two hundred vehicles daily, but it is successfully carrying 10 times that amount of traffic.

Conclusion. — Engineers and road officials cannot afford to ignore the possibilities effecting such savings; nor, in view of hundreds of similar examples throughout the land, can they justify the expenditure of $20.000 to $30,000 per mile where traffic can be served with a lighter bituminous type utilizing existing metal as a base and frequently constructed at a cost of one-tenth of the cost of a standard pavement.

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Charting Second Leg of International Pacific Highway.—An exploration expedition of the Automobile Club of Southern California, on January 17, started to chart the second leg of the International Pacific Highway. This highway is designed eventually to connect Alaska with Buenos Aires. The first leg, from Los Angeles to Mexico City, was surveyed and mapped last summer. The second leg covers the 1,600 or more miles through southern Mexico, Guatemala, Salvador, Nicaragua and Costa Rica, to the Panama Canal.

Permanent International Commission of Road Congresses Modifies Prize Rules

The annual meeting of the Permanent International Commission of Road Congresses was held at Paris on June 27, 1931. Thirty-two delegates from the following twenty countries attended the meeting: French West Africa, Germany, Argentina, Belgium, China, Egypt, United States, France, Great Britain, Greece, French West Indies, Indo-China, Italy, Luxembourg, Madagascar, Monaco, Netherlands, Siam, Switzerland, Jugoslavia.

Mr. H. S. Fairbank of the United States Bureau of Public Roads, and W. L. Finger, Automotive Trade Commissioner to Europe, represented the United States at the meeting.

In opening the meeting Mr. Mahieu, President of the Commission, paid a warm tribute to the organizing committee of the Road Congress which was held in Washington last year, to the work which was accomplished at the congress to the cordial reception extended to all the delegates, and especially to the beneficial results from the highway tours following the congress. He stated that the United States had done more than any other country to promote improvement in methods of road construction and maintenance.

The agenda for the Paris meeting was as follows:

1. Report of the Executive Committee for 1930.
2. Modifications in the rules of the prize established by Belgium in 1910.
3. Study of the resolutions passed by the Washington Congress in 1930 regarding:
   (a) Formation of national committees of the International Association.
   (b) Development of documentary service.
4. Miscellaneous questions.

Report of the Executive Committee for 1930.—The report as presented was adopted without dissent. Special attention was called to the fact that in 1930 the following four governments joined the Permanent International Association of Road Congresses; British Sudan, French Equatorial Africa, Lithuania, Hong Kong. Since the beginning of 1931, Canada has joined the association also.

Emphasis was also laid on the Technical Dictionary of Road Terms in six languages. The finished work will be received from the printer in a few weeks. The executive committee expects to make arrangements later to sell this dictionary, and will request the cooperation of the national committees in the various countries.

In the discussion concerning the report for 1930, and the budget for 1931, the hope was expressed that each country would pay its dues as soon as possible. The budget for 1931 was approved.

Modifications of the Rules for the Prize Established by Belgium in 1910.—Since the conditions under which the competition for the prize have been altered since its foundation, appropriate changes in the rules were proposed and adopted. The following is a translation of the new rules with the changes in italics in each case:

"Article 1. The Permanent International Association of Road Congresses awards *on the occasion of each congress a prize, the amount of which is determined by the Permanent International Commission,* to the author of the best study presented with the object of promoting

progress in the construction, maintenance or exploitation of highways, or in facilitating traffic.

"Article 2. Competitors must be enrolled as permanent members of the Association; *their application for membership must have been made at least six months before the date fixed for the close of the competition.*

"The members of the Permanent International Commission may not participate in the competition.

"Article 3. The publications of the Association *indicate the opening and closing dates of the competition;* the articles should be addressed, *before the close,* all postage and other expenses paid, to the Secretary Genral of the Association, at Paris.

"If the articles are written in a language other than German, English or French, a good translation in one of these languages should be attached to the original.

"Article 4. The articles, written or *typed,* should be dated. *Printed works may be accepted provided they were not published before the close of the preceding contest.*

"Article 5. The prize is awarded by the Permanent International Commission of Road Congresses, on the recommendation of a jury composed as follows:

"The Belgian representative on the Permanent Bureau of the Association, *President.*

"Two Belgian members of the Permanent Commission;

"An English member of the Permanent Commission;

"A German member of the Permanent Commission;

"The Secretary General of the Association.

"The jury will classify the articles presented.

No decision of the jury is valid unless it is approved by a majority of the members; however, in case of a tie vote, the vote of the President is decisive.

"Article 6. The winning article is published *in whole or in part* at the expense and *effort* of the Association, under conditions *fixed by the Permanent International Commission, unless the article has already been published.*

Twenty-five copies, in each of the languages in which the manuscript will have been published, will be placed at the disposal of the author.

"Article 7. As regards the manuscripts *or typed works* which do not win the prize, the Association reserves the right to publish them in whole or in part or to return them to their authors.

"Article 8. In case the articles presented do not seem to justify the award of a prize, the Permanent International Commission may decide to increase the amount of the prize or to award two prizes for the next competition.

In any case, the prize may not be divided.

Honorable mention is not awarded to articles that do not win the prize."

Study of Resolutions Adopted by Washington Congress.—(a) Formation of National Committees of the International Association.

The functions of such a committee would be to act as the national representative of the International Association, to create propaganda for the International Association, and for the road improvement, to distribute notices and information, to take care of the payment of annual dues and other routine business.

Attention was called to the national committee already functioning in England, the British Organizing Committee. The Commission agreed that although different conditions in the different countries might require varying methods of procedure, the British Organizing Committee may be considered an illustration of the type of body which should be set up in other countries. In all cases, the members of the Permanent International Commission should constitute the nucleus of the National Committee. It was explained that in the United States the Highway Education Board will serve as the National Committee. The Commission will send to each delegation a communication relative to the creation of these national committees and their tasks.

(b) Development of documentary service.—It was agreed that in each country the National Committees to be created should draw up periodically lists of the titles and nature of publications issued bearing on road work and should send these lists to the headquarters of the Association in Paris, which will publish them in its bulletins. A communication on this subject also will be addressed to the various delegations by the Commission.

Miscellaneous Questions.—The only topic of any importance considered was the Munich meeting in 1934. The German delegation suggested the first Monday in September, 1934, as the opening date of the Congress, and this suggestion was adopted. The German delegation is already making plans for the meeting with the approval of the Government.

The agenda for the Munich meeting will be considered at the next annual meeting of the Commission, but national delegations are urged to begin studying now questions to be suggested for the agenda. Usually six questions are placed on the agenda, three relating to highway construction, and three to highway use of regulations.

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Shops Are Making Junk Heaps Pay Big Dividends

By C. E. Schnure
Shop Foreman

Making the junk heap pay $50,000 a year dividends is one of the tasks the Phoenix shops of the highway department has recently set about doing in the installation of a reclaim department for automobile parts. On making a survey of FWD and Liberty trucks that were stored in the highway department yards in Phoenix, and which were found to be worn beyond repair, it was decided that it would pay to install a reclaim department. This department could dismantle these old trucks and reclaim the parts in them that were not worn out and were usable as replacements in equipment now in use.

Bins and two sections of racks were installed in the west end of the south sheds for that purpose, the total cost of this installation amounting to approximately $500. These bins and racks are numbered with the parts numbers and as the trucks are dismantled the parts that are usable are placed in these bins and racks, which have now become a stock room for FWD and Liberty truck parts. As the parts are reclaimed a perpetual inventory card system is started on them so that an accurate accounting of all parts is always on hand.

When parts are issued from this stock for replacements in trucks now in use they are charged out at 50 per cent of their list value as a new part. The system has barely gotten underway, but from all indications to date a saving of at least $50,000 will be effected during the coming year by this improvement, a saving that otherwise would have been practically wasted in junking the old trucks as they were not usable.—*Arizona Highways.*

Missouri Paving Contractors *Develop Novel Construction Methods*

Finishing Machine Pulls Strike-Off Template on Mesh Reinforced Pavement Project

By S. H. CLELLAND
Assistant Engineer of Construction, Missouri State Highway Department

CONSIDERABLE thought and effort has been expended in connection with the placing of mesh reinforcement in concrete pavements in an endeavor to secure maximum efficiency in placing and insure final location of the mesh in the finished slab.

In Missouri we have just recently adopted welded wire mesh reinforcement as standard for all concrete pavements, whereas previously we had only been using it in special cases, mainly, near the larger centers of population.

Our design, which was adopted from recommendations made by the Wire Reinforcement Institute, calls for a 9 in., 7 in., 9 in. section using approximately a 44 lb. wire fabric composed of No. 6 gauge wire, the transverse wires being spaced 12 in. centers, and the longitudinal wires 6 in. centers, except that at each side of the sheet four longitudinal No. 0 gauge wires are used spaced 6 in. centers. Transverse planes of weakness and expansion joints are constructed alternately at 40 ft. 4 in. intervals; the fabric being discontinued at each joint, through which slip dowels are placed. Fig. 1 shows typical sections and plan of our present design in detail. The institute clearly outlined methods by which mesh may be placed in pavements by the strike off method efficiently and without any delay as compared to the old one course method without mesh reinforcement.

It is my purpose in this article to outline our type of construction and methods of application, especially with respect to the strike off method of placing mesh reinforcement, this being compulsory in Missouri as we have determined from actual experience that the use of a chair or of sleds does not give satisfactory results. I believe the strike off method now being used in this state is superior to any of the other methods so far developed of which we have any knowledge.

The type of template used for striking of the lower or first layer of concrete is constructed of 2½ in. by 3 in. by ¼ in. angles, four of these being bolted together (see Fig. 2). Shoes are provided at each end so as to permit the template to slide along on top of the

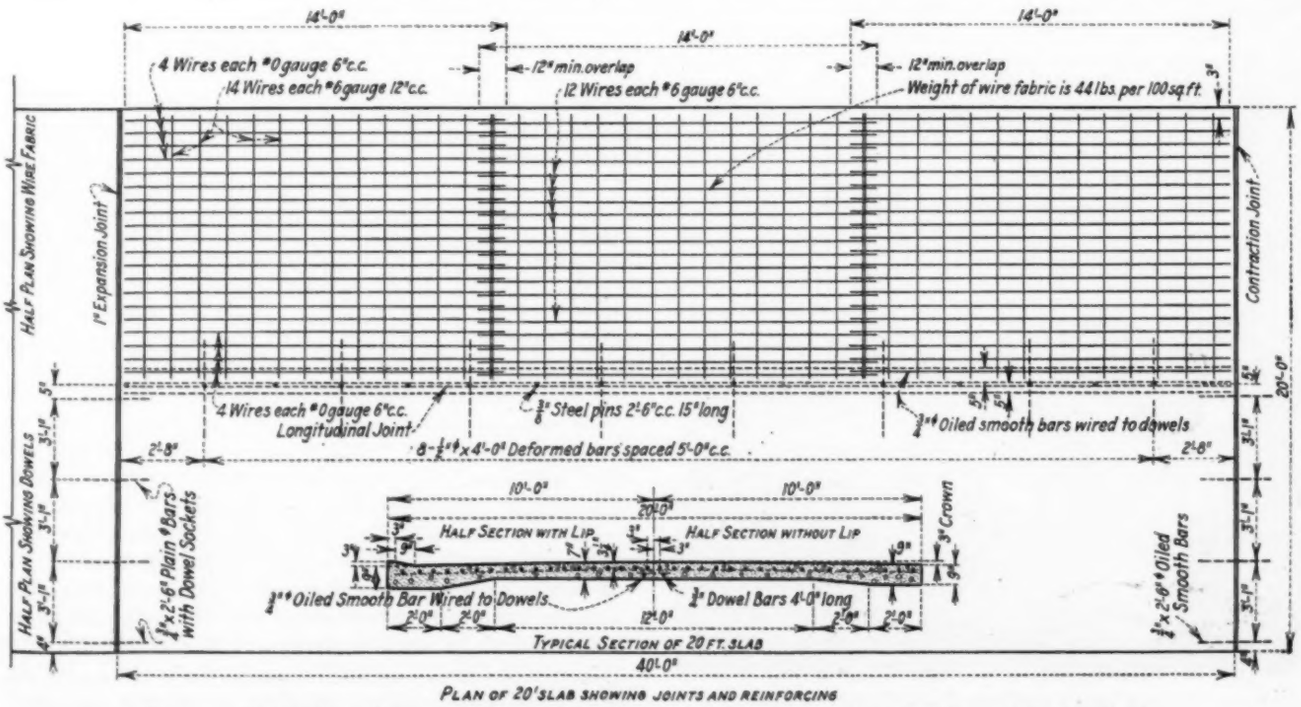

Fig. 1.—Typical Sections and Plan of Missouri Reinforced Concrete Pavement Standard

forms. The bottom of the template is cut to fit the required crown of the roadway.

The type of construction using the angle irons is peculiar to the success of this tool, as in moving the template forward with a roll of concrete ahead of it, the concrete exerts a downward pressure on the horizontal angles, thus making the weight of the template plus that of any concrete on the angles sufficient to prevent the template from raising up off of the forms. In Fig. 3 it will be noticed that two men are riding the

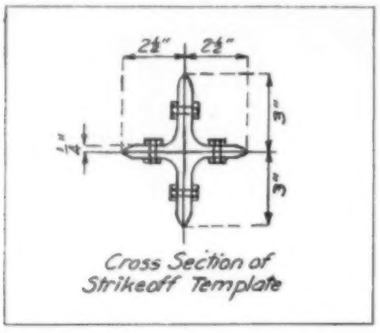

Fig. 2.—Strike Off Template Used by Missouri Contractors

template but in this case it is a convenience rather than a necessity.

It will also be noted in Fig. 3 that two puddlers are working just in front of the template as it moves slowly forward. These men are shoveling the surplus concrete away to prevent it from piling over the top of the template. This labor can be kept to a minimum if mixer operator and pit men are careful in placing and spreading the bottom batches, it being much better to strike off the batches a trifle low in places than to have all consistently high, as the low places will be filled by the excess which is always present in front of the strike off template.

Where expansion joints are used in pavements, they will ordinarily be placed prior to the placing of any concrete on the subgrade, as will also dowel bars, tie bars, etc.; however, the strike off template will not interfere with any of these except the expansion joint, in this case, it is necessary to stop the template at the expansion joint and have it lifted over. Where steel center strip is used, a slot cut in the template will provide clearance.

Several methods of operating the strike off template are in use but the method which we have found most satisfactory is that of using the finishing machine power transmitted through cables to the template as shown in

Fig. 3.—Weight of Template Plus Concrete on Top Is Sufficient for Striking Off Bottom Concrete

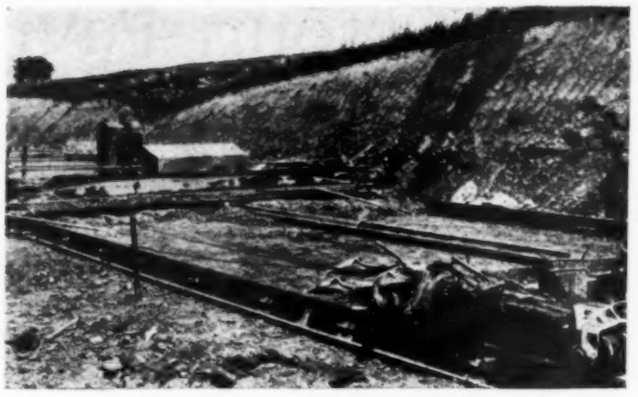

Fig. 4.—Cables From Strike Off Run Through Sheaves Attached to Subgrader

Fig. 4. Flexible ⅜ in. wire cables are attached to the ends of the template and then run through sheave blocks either anchored to the form pins about 30 ft. ahead as shown in Fig. 5, or to the subgrade template attached to the mixer as shown in Fig. 6. The latter is the better arrangement as it is moved forward without any attention as the mixer moves up. The cables then continue back, as shown in Fig. 4, to the finishing ma-

Fig. 5.—Sheave Attached to a Form Pin May Also Be Used As an Anchor for Strike Off

chine. Here they may be provided with hooks which can be attached to the finishing machine at any one of several different points depending upon the position of the finishing machine at the time the template is ready to move forward; however, with this arrangement, it is sometimes necessary for the finishing machine to move into position either forward or backward in order to comply with the fixed cable length. A better method is to allow an extra 30 ft. of cable which will permit a half hitch to be made on the finishing machine at almost any point it may happen to be when the template strike off is ready to be made. (See Fig. 7.)

A proposed improvement for attaching the cables to the finishing machine is being tried out as this goes to press, and should it prove more efficient, a description of it will be submitted at an early date. It is believed possible to eliminate the time and labor necessary to attach and detach the cables to the finishing machine.

After the cables have been attached to the finishing machine, it is then backed away and the strike off template is pulled forward by means of the cables.

No trouble is experienced through lack of power on the part of the finishing machine to operate the template, and no loss of finishing time need occur, as the

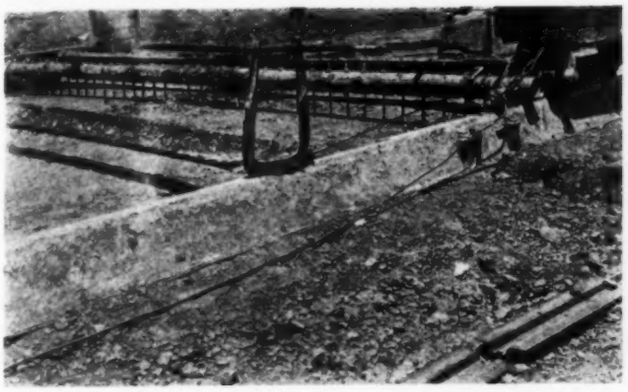

Fig. 6.—Strike Off Cable Sheave Attached to Subgrade Template

finishing machine operator may make use of his time while pulling the template to tamp his pavement as he backs away.

Immediately after the strike off has been made (and it should be made as soon as the bucket has dumped the last bottom batch and while the mixer is mixing the next batch) the mesh reinforcement is placed. In the case of a two lane pavement, the cover batch of concrete may be

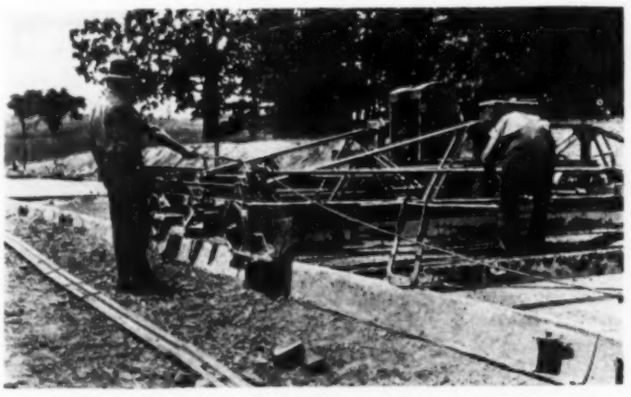

Fig. 7.—Showing How Half Hitch Is Made on Finishing Machine

dumped as soon as the first sheet has been placed on one side and while the workmen are placing the sheet on the opposite side.

The cover batches should be placed one in each far corner away from the mixer as shown in Fig. 8. In the case of a 6-bag batch, one batch will about cover a 14 ft. sheet of mesh for the full 10 ft. width.

One important feature of using the finishing machine and cable arrangement is that it is applicable to jobs where the mixer is operated outside of the forms as well as on jobs where the paver operates on the subgrade. Of course in this case the mixer or subgrade template cannot be used as an anchor and the sheave blocks must be attached to the form pins ahead. In this connection it should be stated that no trouble is experienced with this method in pulling pins or forms out of position.

Where the method of attaching sheave blocks to form pins is used and hooks are used for attaching to the finishing machine, about 75 ft. of ⅜ in. cable is sufficient for one side; however, when attaching to the template behind the mixer and with the hook attachment to the finishing machine, 50 ft. is sufficient on each side. Using the recommended method of half hitching to the

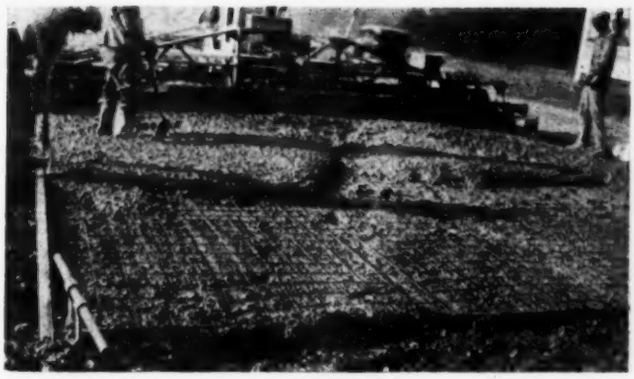

Fig. 8.—Placing Cover Batches

finishing machine about 30 ft. of cable extra per side should be allowed.

The above described methods and details are now being used by all contractors on mesh reinforcement jobs in Missouri and in every case, they have met with highest favor from both contractors and engineers.

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Good Drivers Defined

There are drivers who almost never get into the hospital or the police court. They are good drivers.

Accidents the good driver avoids with ease are:

Crashing into the car ahead, because he keeps back his proper distance, and allows himself time to stop.

Read end collisions, because he uses his rear-sight mirror to keep a check on the man behind and signals him his intention of stopping, in time.

Sideswiping, because when he decides to pass the car ahead he announces his intention with the horn, to make sure the road in front is clear, and then swings out and around in a wide, easy curve that leaves the other fellow plenty of room.

Being sideswiped, because when the man behind sounds the horn the pass, the good driver gives him the road, and does not speed up in an attempt to "freeze him out," or swing over toward the middle of the road to squeeze him out.

Head-on collisions, because good drivers are sure the road ahead is free from oncoming cars before trying to pass a car traveling in the same direction.

Good drivers do not pass cars on curves, or anywhere else where a clear view of plenty of road ahead cannot be secured.

Good drivers have their own headlamps properly adjusted to avoid blinding the other fellow. If the other fellow isn't so considerate, good drivers have a non-glare visor for emergencies.

Going into the ditch usually occurs at night, and good drivers carry road lamps which enable them to keep on the road, in spite of fog, or the glare of oncoming cars.

Grade crossing smashups are avoided by good drivers not trying to beat a train across, and by never merrily sailing around the car ahead which had the good sense to stop when it saw an approaching train which was hidden from the cars behind.

Ninety per cent of the day's accidents come within the foregoing category, and the good driver easily avoids 90 per cent of these.—*Arizona Highway Journal.*

Panama's Share of Inter-American Highway Eighty Per Cent Complete

Suspension Bridge Over the San Pablo River in Panama Near Soma. Total Length Is 130 Meters

HOW American dollars have been put to work in the construction of modern roads in Panama was explained by Senor Tomas Guardia, chief engineer of the Central Road Board of Panama, now in this country to obtain financial accommodation for the completion of the National Highway of Panama. Senor Guardia told how the proceeds from the $12,000,000 loan sold in 1928 by the National City Company had been expended and how, since the depression wave set in, spread more thinly to provide work for persons who otherwise might have been unemployed.

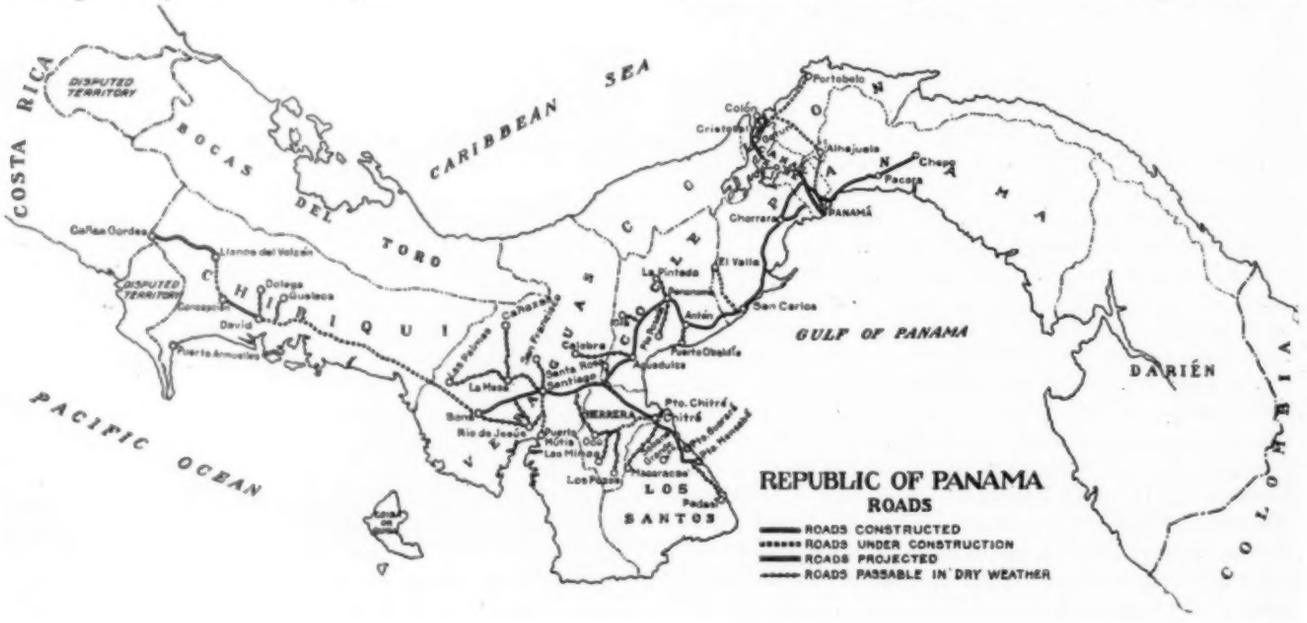
The National Highway of Panama, which eventually will extend from the Costa Rican border to the Colombia frontier, has been under construction since 1921—intensely since 1928. For the first few years funds for the work were derived from current revenues which were later supplanted by proceeds from loans. Since the start of the work, over $15,800,000 has been expended and 850 miles of road have been constructed.

Senor Guardia estimates that revenues from the levy of an eight-cent-a-gallon tax on gasoline, plus 25 per cent of the automobile registration tax, will prove sufficient to keep the work going until the end of this year. The rainy season in Panama lasts from May until December and work now naturally is going on at a reduced rate. He estimates that about 1,500 men are at work now as compared with a total of 4,500 to 5,000 during the dry months of the year.

When the $12,000,000 loan was made three years ago, the Panama road board planned to use it in road construction at the rate of about $500,000 per month. A slower rate was decided upon and instead of drawing the full amount in the first ten months, the board only drew the last $100,000 on May 28, 1931, more than thirty months after it had been made available. Of the original $12,000,000, $1,092,745 was set aside for the purchase of equipment and completion of roads under construction and $4,000,000 was set aside for construction of the main highway between Santiago and David.

Senor Guardia discussed the progress which is being made and the method of construction as follows:

"Since 1920, the Republic of Panama has followed a very progressive and efficient policy of road building and has attained in the space of ten years an enviable position among the countries of Latin America in the field of highway development. Two principal reasons account for this success. The first is that in 1920, Panama was foresighted enough to place all its road building activities under control of a central road body, which is an independent, autonomous organization, free from political influences. The second reason is that specific revenues, such as gasoline and automobile license taxes, mainly derived from the use of highways are turned over directly to this board, insuring the maintenance and improvement of existing roads and



the continuance of a coordinated construction policy.

"Panama has more than 850 miles of complete highways and semi-improved roads which are passable by automobile during the dry season. This total is divided as follows: first class roads completed, 285 miles; first class roads under construction, 172 miles; secondary roads, 186 miles, and dry season roads, 210 miles. These Panama roads have been inspected by officials of the United States Bureau of Public Roads and their reports have been highly complimentary."

Describing the use to which the funds for road construction have been put, Senor Guardia said:

"A little more than $1,000,000 was devoted to the purchase of equipment and to the improvement and completion of roads which were already under construction at that time, including a short section of twelve miles between Chorrera and Arraijan. This new section when connected to Panama by a new ferry service and by the Thatcher Highway now being built by the United States Government in the Canal Zone, will constitute a great improvement and will give easy access to the highway system of the interior, which may now be reached only through a long and tortuous road. Four million dollars from the proceeds of the loan were used to build a new highway 155 miles long (250 kilometers) from Santiago de Veraguas to David. The highway parallels the main Cordillera, crossing many spurs from the main range and a great number of rivers, some of considerable size. The drainage of the highway proved particularly costly and the grading was very heavy. Forty-one bridges of a span of 65 ft. or more were required with 48 additional single girder bridges ranging in span from 20 to 40 feet.

"The foundations of the Span Pablo Bridge, which has a main span of 380 feet with two approach spans of 80 feet each, were sunk by compressed air 40 feet below ground and 30 feet under water. The Fonseca Bridge has a main span of 400 feet with two 80-foot approaches. The Tabasara Bridge has two 225-foot spans and the Santiago Bridge has a 260-foot span, The aggregate length of the steel bridges required in the construction of the new highway is 6,460 feet and they required a total of 3,906,200 pounds of steel. An old suspension bridge of 400 feet span over the Chiriqui River has been reconditioned and will be replaced later by a new bridge 560 feet long.

Mechanized Grading Outfit on Santiago-Sona Section of Inter-American Highway

"Grading was light in some sections and very heavy in others, reaching a maximum of 44,000 cubic yards per mile. The total volume of excavation amounts to 2,100,000 cubic yards, about 10 per cent of which was in rock. In addition, 43,000 cubic yards of additional excavation was made for bridge abutments and other structures. The surfacing, principally treated macadam and gravel and including the rock foundation, amounts to 102,000 cubic yards. Concrete masses were poured to an aggregate amount of 23.500 cubic yards and reinforcing steel weighing 1,308,000 pounds was

Drilling, Crushing and Screening Plant for Rock for Chorrera

used. Nearly 11 miles of corrugated pipe have been used for culverts and the new fences for the right-of-way total over 105 miles in length. Eighty per cent of the road is completed. The most modern and up-to-date machinery for the construction of highways is being used by the Central Road Board of Panama, including power shovels, tractors, graders, scrapers, crushing plants, gravel plants, etc. The estimated value of the mechanical equipment now in use by the board is more than $1,000,000.

Aclila Bridge on the Santiago-Sona Highway During Construction. Central Span Is 40 Meters and Approach Spans Are 12 Meters Long

"Panama feels that what has already been accomplished is only a beginning in her efforts to promote the development of her natural resources. Besides the completion of roads already started, she is contemplating construction of a new road between Panama and Colon and the extension of the present road system to the Costa Rican boundary. This will complete Panama's share of the proposed inter-American highway."

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1930 Gasoline Tax $494,683,410: All States Levy on Motor Fuel

The gasoline tax yielded a net revenue of $494,683,410 in 1930 and nearly fifteen billion gallons of gasoline were used by the motor vehicles of the United States, according to reports received by the Bureau of Public Roads of the U. S. Department of Agriculture from State agencies.

As compared with 1929, the tax revenue increased 14.6 per cent and the consumption of gasoline increased 3½ per cent in spite of the fact that there was no increase in the total number of motor vehicles. The average consumption per vehicle was 556 gal. in 1930 as compared with 538 gal. in 1929.

A gasoline tax was imposed in all the States, the rate ranging from 2 to 6 ct. per gallon. The average rate was 3.35 ct. per gallon. The net revenue of $494,683,410 was allocated as follows: $1,102,187 for collection expenses; $338,927,564 for state highways; $96,225,637 for local roads; $20,869,901 for state highway bond payments; $10,179,135 for local road bond payments, $11,842,930 for city streets; $13,404,200 for schools, and $2,131,856 for miscellaneous expenditures.

The average of the annual registration fees is $13.41 and this added to the average gasoline tax of $18.62 made a total direct tax on the motorist of $32.03. These two taxes formed the largest item of revenue for highway purposes.

An analysis by the bureau shows that the average consumption of gasoline per motor vehicle was 452 gal. in 1925 and there has been an increase each year to 556 gal. in 1930. This increase is thought to be the result, in part, of the increased percentage of trucks and other commercial vehicles but it has also been influenced by increased use of the average vehicle.

GAS TAX RATE AND RECEIPTS IN 1930

State	Tax Rate on Dec. 31, 1930—Cents per Gallon	Total Tax Receipts	Gallons of Gasoline Used by Motor Vehicles
Alabama	4	$ 6,901,492	172,537,281
Arizona	4	2,670,019	66,750,478
Arkansas	5	6,427,273	128,545,469
California	3	34,870,126	1,162,337,545
Colorado	4	6,144,826	153,620,645
Connecticut	2	4,515,063	223,296,627
Delaware	3	1,013,357	33,778,561
Florida	6	13,655,175	227,036,915
Georgia	6	13,435,062	223,184,648
Idaho	5	2,730,862	54,422,752
Illinois	3	27,472,420	915,747,319
Indiana	4	17,158,834	428,968,653
Iowa	3	10,584,068	352,802,277
Kansas	3	9,120,491	304,016,374
Kentucky	5	8,414,733	168,294,655
Louisiana	5	7,546,448	184,781,753
Maine	4	4,168,890	102,737,416
Maryland	4	6,991,188	174,779,706
Massachusetts	2	10,562,947	528,147,350
Michigan	3	21,713,489	722,462,626
Minnesota	3	10,359,111	345,303,709
Mississippi	5	6,917,575	135,823,574
Missouri	2	8,639,161	431,958,050
Montana	5	2,941,879	58,837,575
Nebraska	4	9,060,422	226,510,543
Nevada	4	675,012	16,875,292
New Hampshire	4	2,499,478	62,486,940
New Jersey	3	11,380,231	546,685,108
New Mexico	5	2,761,887	54,385,614
New York	2	28,476,290	1,438,582,716
North Carolina	5	12,533,454	250,669,089
North Dakota	3	1,971,986	65,643,460
Ohio	4	37,081,451	927,036,272
Oklahoma	4	12,092,420	302,310,488
Oregon	4	6,198,777	154,986,497
Pennsylvania	3	33,623,510	928,842,534
Rhode Island	2	1,735,747	86,612,980
South Carolina	6	7,145,711	119,071,835
South Dakota	4	3,503,882	87,597,064
Tennessee	5	10,719,195	214,383,900
Texas	4	29,527,098	738,177,457
Utah	3½	2,105,529	60,137,811
Vermont	4	1.879,921	46,998,012
Virginia	5	10,775,058	215,501,157
Washington	3	7,253,249	241,774,964
West Virginia	4	5,367,078	133,965,701
Wisconsin	2	8,314,841	415,742,027
Wyoming	4	1,447,005	36,175,118
Dist. of Columbia	2	1,599,689	79,984,431
Total	3.35	$494,683,410	14,751,308,978

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Speed Has Changed Road Requirements

Many roads have just grown up with the country and as these roads built for travel at low speed evolved into paved roads little change was made in the location. "Modern high speed traffic demands revision of such low speed roads," states R. G. Browning, chairman of the road location committee of the American Road Builders' Association.

"A car traveling 60 miles an hour passing a car at 45 miles an hour will encroach on the left lane of traffic for a distance of 468 feet. A road safe for passing cars on its entire length must be straight enough and have the tops of hills rounded so that a driver can see at least 500 feet ahead. Many old locations fail to meet this condition," concluded Mr. Browning.

Mixed-in-Place Construction in the Western States

Results obtained with use of crushed stone and gravel in this type of work

By J. T. PAULS
Senior Highway Engineer, U. S. Bureau of Public Roads

IN the western method of mixed-in-place highway construction aggregate is obtained either by scarifying the old base or by adding new material or both. The bituminous material is applied in about one-half gallon applications by pressure distributors until the desired amount has been spread. Discing immediately after each application is generally done, which not only effectively aids in the mixing but also prevents the freshly applied oil from adhering to passing vehicles.

After the required amount of oil has been added the materials are further mixed with blading machines by repeatedly windrowing and spreading until all the aggregate is covered and the mix is uniform in appearance. Areas that are lean are given an additional application of oil and then remixed. In the same manner, areas which are too rich are remixed with additional aggregate.

Typical Unloading Plant with Boiler, Retort and Storage Tanks

To aid in handling traffic, the aggregate is generally placed in two windrows along each edge and mixing completed on each, after which they are combined and remixed in the center of the road thus allowing the passage of traffic throughout the complete operation. Speed and plenty of power are essentials in efficient mixing.

When the mixing operations are complete the mix is spread to a uniform cross section for compaction, which may be secured either by rolling or by traffic or by both. Generally it is advisable to roll the surface when a heavy bituminous material, such as a cut-back asphalt or asphalt emulsion, is used. The thickness of the finished surface ranges from 1½ to 3 in. compacted, with a majority of work 2 in. thick. Washington seems to be the only state using the minimum thickness and this may be explained by the fact that this type of construction in Washington is regarded as more of a temporary improvement to be later strengthened by surface treatments or replaced by a higher type of construction. Washington also applies a prime application of the light oil to the base, which no doubt not only strengthens the base construction but the surface as well. However, with the exception of Washington, there seems to be a growing tendency to regard 3 inches compacted as the minimum thickness necessary to give a satisfactory surface mat.

The type of aggregate used in this construction includes both gravel and crushed stone of a maximum size of about 1 to ¾ in. and graded to dust. With the use of the light oils it is necessary to have high inherent stability and interlocking of fragments, while, with the heavier bituminous materials, this is not so important. With the former material the custom is to have 5 to 10 per cent or more of material passing the 200 mesh sieve, while, in the latter, the crusher run material should prove highly satisfactory. Although the maximum size

Disc Harrow Is Generally Used After Each Application of Bituminous Material

of the aggregate given above is that generally used, the indications are that the maximum size of stone used in this type of work should not be larger, particularly for the light oil material, and might satisfactorily be considerably smaller. There is a tendency for the coarser particles of aggregate to be loosened from the surface and thrown to the edges by traffic. It is believed that a smaller maximum size would reduce the segregation and subsequent raveling.

The following table gives the average grading of the crushed stone and gravel aggregate, as well as the amount of oil used in typical oil mix projects in several states:

	Per cent by weight passing				Oil used Per cent
	1 in.	¼ in.	10 mesh	200 mesh	by wt.
Wyoming	95.3	69.5	50.9	7.0	4.3
New Mexico	98.9	75.5	58.0	5.9	4.3
Idaho		50.6	37.3	6.1	4.0
Utah			35.5	7.8	3.7

The quality of the aggregate is important, particularly with the use of light oils. Until recently the material was considered satisfactory when the fines had a cementing value of not less than 100 by Page impact test,

One Man Power Driven Blade Is Generally Used to Complete the Spreading and Smoothing After the Completion of Mixing

moisture equivalent of not more than 20 per cent, and lineal shrinkage of not more than 5 per cent. More recently it has become evident that these requirements did not indicate definitely the suitability of the aggregate for light oil mixing. A considerable number of rapid failures of these roads which were at first believed to be due to the character of the oil, particularly as to the quantity of paraffin contained, have, after more careful study, been definitely determined to be due to the character of the aggregate. Experience with the light oil mix construction shows that there is a tendency for the slow rise of the oil to the surface even under dry conditions, necessitating the remixing of the surfacing as frequently as every two or three years, and where moisture conditions are not so favorable, the rate of this movement is greatly increased. It is believed that where rapid failure of the surfacing has occurred that a considerable percentage of the aggregate has been of the character possessing low affinity for the oil, with the result that water easily displaces the oil and causes very rapid movement of the oil to the surface.

Potholing and Ravelling Develops in the Surface When Insufficient Oil Is Used in the Construction. A Remedy for This Condition Requires Either the Remixing with Additional Oil or the Application of a Surface Treatment

Federal-aid Project 295-B in San Luis Valley, Colorado, is a striking example of rapid and complete failure from the combined effect of bad moisture conditions and unsuitable aggregate for the light oil mix treatment. This project, about 10 miles in length, was constructed with crushed gravel and 60-70 per cent oil in the fall of 1929. During the following spring the surface failed completely from rutting, shoving and raveling, and it

Mixing in Two Windrows to Permit Traffic During Construction

was only with frequent remixing, as often as every two weeks, that the surface was kept passable during the early part of the summer. The unusual behavior of this construction is undoubtedly due to the aggregate, since an adjoining mixed-in-place project on the same road and under identical conditions except for different aggregate has given excellent service for three years without very appreciable maintenance.

Several of the western states now recognize the importance of the aggregate in connection with the light oil mix construction and are determining the behavior of the various aggregates in oil mixture before attempting their use in this construction.

A test along this line has recently been devised to determine the preferential absorption of the aggregates for water and oils and thereby the suitability of the aggregates for light oil mixing. This test is known as the "swell test" and was first used by Mr. Powers of Arizona. The method for making this test in the Bureau of Public Roads laboratory is to mix the aggregates with approximately the amount of oil which would be used in the construction. One thousand

Mixing with Blade Machine Follows Immediately After the Final Application

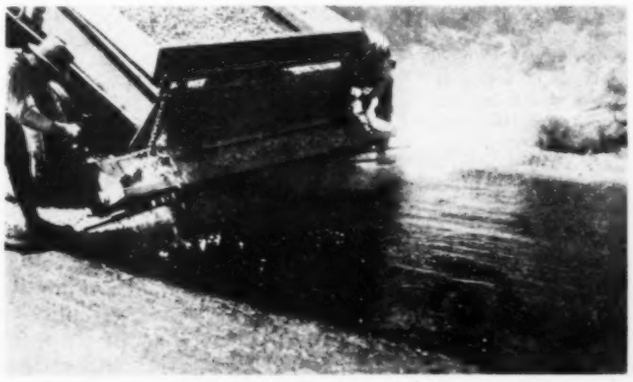
grams of the mixture is then placed in a cylinder 4 in. in diameter and 6 in. high and molded under a pressure of about 2000 lb. per sq. in. After compression the specimen is left in the mold and a slip cover made of No. 40 mesh sieve supported in a frame is placed flush against the under side of the mold. The mold containing the specimen is then placed in a water bath so

that there is a ⅛ in. clearance from the bottom of the tank. The water level in the bath is kept about 1 in. above the surface of the specimen, while the specimen in the mold is covered with about ½ in. of water. The

Light Oils Rise Slowly to the Surface of the Mix Under Normal Conditions Requiring Periodic Remixing Every Two or Three Years to Redistribute the Bitiminous Material in the Aggregate. With Aggregate Having a High Affinity for Moisture and Where Moisture Conditions Are Unfavorable Failure of the Surface May Develop Rapidly. The View Shown Is Typical of the Rapid Movement of the Oil to the Surface Due to These Conditions and Not to Richness of the Mix

amount of swelling is measured on the top of the specimen by means of an Ames dial, contact with the specimen being made by a thin metal disc 1 in. in diameter. Readings are taken at regular intervals until maximum swelling is obtained. A swelling of as little as $\frac{1}{10}$ in. indicates that only mediocre success can be expected from the use of the particular aggregate. Aggregates entirely unsuitable for mixing have given a swelling as great as ¾ in. under the conditions of this test.

Another test for the suitability of the fine aggregate is the "emulsification test." The method is essentially to combine 10 grams of the fines passing the 200 mesh



Surface Treatments Very Often Applied to Old Oil Mix in Preference to Remixing and Adding More Oil. Attachable V Type Spreader Is Used to Advantage on This Type of Work

sieve with 50 c.c. of 60-70 per cent road oil, which has been warmed to a temperature of 130° F. in an 8-ounce wide mouth bottle. The mixture is then stirred for five minutes with an electric mixer having a rotating paddle. At the end of five minutes 100 c.c. of water heated to 130° F. is added to the oil mixture and the stirring continued for an additional five minutes. In this test unsatisfactory fines will separate from the oil and be deposited at the bottom of the jar while the satisfactory material will remain coated in the oil.

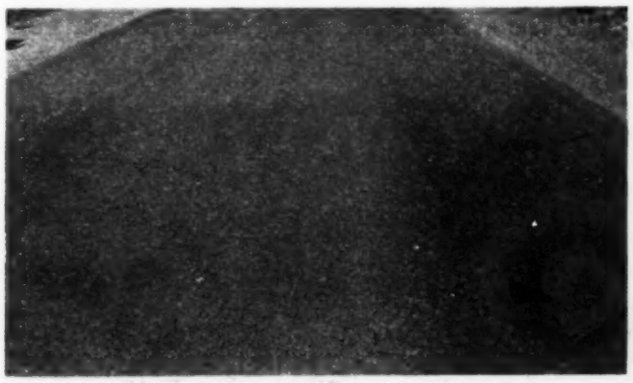
In the comparison of the test results and the surface behavior of the light oil mix type of construction built

Mixed in Place Surface in Which a 70-80% Road Oil Was Used. With the Higher Asphalt Content There Is an Appreciable Increase in the Plastic Qualities of the Mix

with aggregates on which tests have been made, we believe the results indicate definitely that these tests may be used to determine the suitability of the aggregate for light oil mixing.

The amount of oil necessary to give a satisfactory surface depends largely on the grading and character of the aggregate and to some extent on the type of oil used. The finer the material the more oil is necessary, which is also the case when the aggregate is of the character which absorbs the oil. Generally the heavier the bituminous material the more is required. Allowance should also be made with the use of cut-back materials for a certain per cent of loss of the solvent used.

There are several methods being used by the various states to determine the amount of oil necessary. First, the cut and dry method, namely, determining the amount of oil on a short portion of the road and using



Cut Back Asphalt with Kerosense Has Been Used in Mixed-in Place Construction with Both Crushed Stone and Gravel of Various Gradings. The View Shown Is a Surface Appearance Obtained Using Crushed Stone from 1-In. to ⅛-In. in Size. It Is Believed That with This Type of Bituminous Material the Crusher Run Aggregate or the Equivalent Would Be Most Economical and Prove Entirely Satisfactory

this as a guide in conjunction with the grading of the aggregate determined periodically for the remainder of the road. Various formulae, based on surface area theory, such as the one developed by McKesson and

Frickstad, have come into use. The McKesson and Frickstad formula, used with a stain test, was developed primarily on the basis of the experience in Southern California. The tendency, particularly in colder cli-

A Typical Light Oil Mixed in Place Surface in Excellent Condition After Two Years Service

mates, is to use considerably more oil than called for by this formula and considerably better results are being secured.

The McKesson and Frickstad formula for determining the amount of oil necessary is as follows:

$P = .015a—.03b—.17c$

Where P = percentage of oil required

a = percentage of aggregate retained on 10 mesh sieve

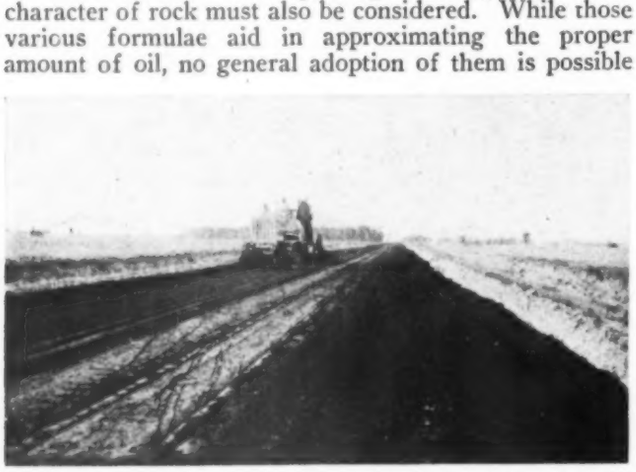
b = percentage of aggregate passing 10 and retained on 200 mesh sieve, and

c = percentage passing 200 mesh sieve.

Wyoming, Utah, and New Mexico have all used the McKesson and Frickstad formula with factors which give a greater percentage of bitumen than called for by the basic formula.

California has recently developed the following formula:

$P = .020a—.045b—.18c$, where a, b and c have the same values as in the earlier McKesson and Frickstad formula. However, there are certain alternative values for the factors where the grading is not typical, and the character of rock must also be considered. While those various formulae aid in approximating the proper amount of oil, no general adoption of them is possible



Oil Mixed-in-Place Construction Using Blow Sand in Nebraska

without a thorough knowledge of local supplies and local climatic conditions.

The amount of moisture in the aggregate is important in determining the amount of oil, particularly if the appearance of the mix is taken as a guide, as a small amount of moisture is all that is needed to give the mix a false appearance of excessive richness.

The light oil products so far used in the oil mix treatments come from a number of fields, chiefly in

Side View of Attachable V Type Spreader in Use

California and Wyoming. So far neither the service behavior nor laboratory tests have shown the material from any one field or the method of manufacture to have any important effect on this type of construction. The various light oils so far used have been of the types obtained by straight topping of the crude petroleum, as residues from steam distillation and as residues and by-products of different cracking processes. The oil mostly used contained 60-70 per cent asphalt of 80 penetration and of a specific viscosity (Engler at 122°F.) of about 50-80. With the higher viscosity the practice is generally to heat the material to aid in applying particularly during cold weather.

As a step towards standardizing and simplifying the requirements for road oils, a conference of the highway officials of several western states was held at Portland, Oregon, in February, 1930. Of the several specifications adopted as standard, the following specification for road oils for mixed-in-place construction was agreed on:

Asphaltic residue of 80 penetration	63+
Viscosity, Saybolt-Furol at 122°F. (sec.)	200-300
Float test at 25°C. (sec.) maximum	200
Flash point, Pansky-Martens (°F.) minimum	225
Water and sediment (per cent) maximum	2
Bitumen soluble in CS_2 (per cent) minimum	99
Bitumen insoluble in CCl_4 (per cent) minimum	99.65

Although the light slow-drying oil products have been used almost exclusively in the mixed-in-place construction in the west, it has been the belief of many that the use of a heavier binder would give better results in this type of construction, particularly on roads carrying fairly heavy traffic and those where moisture, climatic conditions and the aggregates available are not entirely favorable. With this in mind a number of experimental sections were built by California in cooperation with the Bureau of Public Roads in which two grades of asphaltic materials, a 94+ asphaltic road oil and a 100-120 penetration asphalt cut back with kerosene and a slow drying asphalt emulsion were used.

Although it is too early to draw final conclusions from these experiments and other work as to the suitability and limitations of these materials in this type of work, the early favorable results obtained, particularly with the asphaltic materials cut back with kerosene, seem to indicate that these cut-back materials will prove highly satisfactory on this type of work with aggregates of the approximate size and grading now used in light oil mixes.

Typical specifications for two grades of cut-back

materials suitable for this work are as follows:

The finished products shall be made from a 100-120 penetration asphaltic cement and a 94+ per cent asphaltic road oil complying with the specifications for these respective base materials.

For the finished product:

	94+Per cent Asphaltic Road Oil	100-120 A. C.
1. Specific gravity 25°/25°C. not less than	0.950	0.950
2. Flash point (°C.) open cup, not more than	80	80
3. Specific viscosity (Engler) 50 cc., 50°C.	50-80	50-80
4. Bitumen soluble in CS_2 (%), not less than	99	99
5. Bitumen insoluble in 86° Baume naphtha	5-22	5-22
6. Loss at 163°C., 5 hrs. 50 gm. not more than	20%	25%
Residue from loss at 163°C. should have a float at 50°C. (sec.)	80-180	not less than 100
7. Asphaltic residue of 80 pen., not less than	75%	70%

The solvent to be kerosene having a flash point not lower than 115°F. (closed cup) and end point on distillation not higher than 625°F.

Such data as are available indicate that the cost of the oil-mix treatment, exclusive of aggregate, ranges from $1,000 to $2,000 per mile for an 18 ft. width of 2 to 3 in. compacted depth. This does not include the cost of macadam which varies considerably, depending largely on the cost of the aggregate in place. For a large amount of this work under a wide range of conditions the cost of a 5 to 6 in. compacted macadam course ranges from $3500 to about $4500 per mile.

As to the cost of maintenance of the oiled roads only meager information is available. However, such as there is seems generally to indicate that the treated roads are economical in comparison to the untreated. On approximately some hundred miles of light oil mix roads in New Mexico one to two years old, the average cost of maintenance was found to be approximately $200 per mile. In Wyoming, during 1928, the cost of maintenance averaged $330 per mile, while in Idaho during the same year 600 miles of untreated macadam cost $285 per mile, exclusive of material replacement as compared to $294.00 per mile on 200 miles of oil treated surfaces.

In conclusion, I believe it can be said that:

1. The mixed-in-place method as constructed in the west give unexcelled riding qualities to the surface.

2. This method of construction is adaptable to many types of aggregates and slow drying bituminous materials.

3. The results obtained compare favorably, under the best conditions, with those obtained with plant mixing, using the same aggregate and oil.

4. The development of satisfactory portable road mixing equipment for handling the aggregate directly from the road windrow may be expected in the near future. This should still further increase the possibilities of the mixed-in-place method of construction for use with certain types of material which are not entirely suitable for the present machine mixing.

5. The light oil mixed-in-place treatment is proving highly satisfactory in the arid and semi-arid sections, while in the colder and more moist areas results have not been so favorable.

6. The character of the aggregate rather than any difference in the light oils is believed to be responsible for many rapid failures occurring, particularly under moist conditions. Preferential absorption of an appreciable portion of the aggregate for water as compared with oil may be the cause of these failures. It is felt that data secured from the swell test and the emulsification test will aid in showing the suitability of the mineral aggregates for this type of construction and minimize the failures from this source.

7. Recent experimental work indicates that a heavy asphaltic oil or soft asphalt cement cut back with a distillate, such as kerosene, naphtha, a combination of both or a suitable asphalt mixing emulsion, should be used in the mixed type where aggregate and moisture conditions are not highly favorable.

8. When the gravel or crushed stone road is stable and well bonded a surface treatment, using a hot application material, a quick drying asphalt cut-back or a suitable asphalt emulsion, should prove more satisfactory and economical than a light oil mix treatment. A considerable mileage of light oil mix surfaces has been built in the west where conditions were more suitable for the surface treatment type.

9. Light surface treatment to give a wear resistant mat may often be added economically to an oil mixed surface as maintenance rather than scarifying and remixing with additional oil as is now generally done.

Acknowledgment.—The above is taken from a paper presented before the Ninth Asphalt Paving Conference.

Some People Learn

Trying to do business in an unbusinesslike way is expensive, but how slow we are to learn it. We are led to hope that contractors will some day learn that lesson by the fact that it has been learned by at least one person. We are told that in the Black Belt of Alabama there is displayed behind the counter of a cross-roads store, this sign:

"KWITTEM CREDICK BIZNESS
TILL I GETS MY OUTS IN."

A little reflection on the present price situation in the construction field indicates that unless some firms "Kwittem credick bizness" they will have posted on the locked door of their place of business, a sign reading:

"Kwittem Bizness
Outs Not In."

—*The Construction Advisor.*

Who Gets the Tourist Dollar?

There seems to be some argument in various sections of the country among merchants as to who gets the tourist's dollar that may be spent in the community. The United States Department of Commerce has been making a study of this new industry and they give the following percentages as being about correct. It must be remembered that in some communities the actual figure will vary according to accommodations offered:

Retailer	25 per cent
Restaurant	20 per cent
Hotel or Camp	17 per cent
Garage and Filing Station	12 per cent
Transportation	10 per cent
Theatres and Amusement	10 per cent
Confectionery	6 per cent
Total	100 per cent

Usually the retailer is the first one to say that his sales is not affected by the tourist. He is overlooking the fact that in his case the money does not go from first spender to merchant. He gets his volume from the pay envelope of the employe of the filling station, garage, hotels and restaurants.

Safety, Convenience, Appearance Govern

A Three-Lane Pavement Carrying Only Two Lines of Traffic Through a Subway at Coxsackie. Note White Marker and Warning Sign. Subway Columns at Edge of Sidewalk

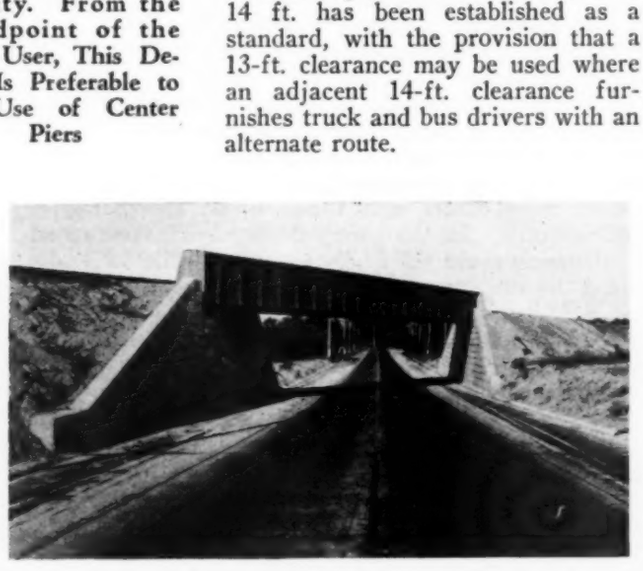
A Heavy Steel Girder Spanning a Four-Lane Highway in Erie County. From the Standpoint of the Road User, This Design Is Preferable to the Use of Center Piers

Pictures from

H. O. SCHERMERHORN

Assistant Chief Engineer, New York State Department of Public Works, Albany, N. Y.

POLICIES pursued by the state of New York in planning grade-separation structures are illustrated in these views of typical grade-elimination projects. Adequate vision to the highway user is recognized as being of primary importance, and a sight distance of 1,000 ft. has been established for main highways in the state. Where this is impracticable, compensation is afforded by additional width and proper warning signs. Grades are held to less than 5 per cent where this is possible. A minimum radius of 800 ft. has been adopted for overhead structures on curves, but this is regarded as a last resort, and an effort is made to increase the radius wherever possible. A clearance of 14 ft. has been established as a standard, with the provision that a 13-ft. clearance may be used where an adjacent 14-ft. clearance furnishes truck and bus drivers with an alternate route.



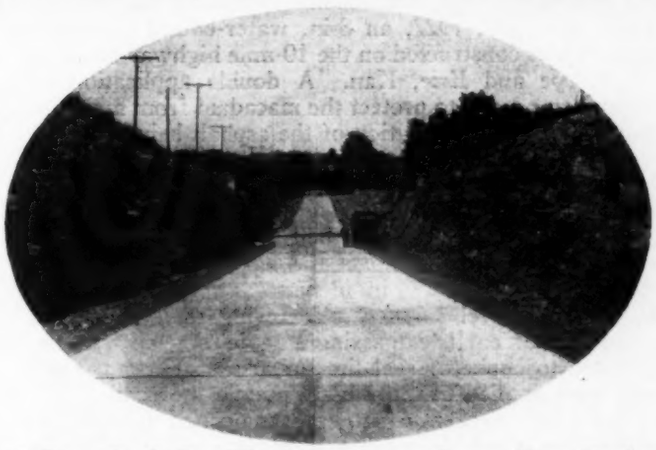
Left—A Gunited Steel Span in Nassau County. Six Drainage Receptacles Are Provided. Right—Inadequate Vision Compensated for by Increasing the Width of Pavement at This Suffolk County Underpass

An Overpass at Schenectady on Easy Grade and Curve

Design of New York Grade Separations

Subways are acknowledged to be generally more satisfactory structures than overhead designs, but frequently the difficulties of securing proper clearance and of providing for drainage are factors which favor the overhead crossing. Center piers are discouraged as a hazard to the highway user. Overhead or underpass structures of three-lane capacity are discouraged, and existing three-lane highways are marked for two lanes of traffic through such structures. Consideration is given to the appearance of the separation structure in relation to the general terrain and the character of the surrounding community.

New York state has experienced the necessity of reconstructing grade-separation structures only a few years old, the better to serve increasing modern traffic, and this has emphasized the necessity of sufficient traffic studies as a preliminary to all grade-elimination planning, and the adoption of designs which consider the safety of the highway traveler. A guiding principle is that in removing the danger of a grade crossing, no hazard should be introduced which did not exist prior to the creation of the separation structure.



An Elimination in Clinton County. Note Guard-Rail at Subway Approach and Abutment Markings

A Deep Rock Cut Was Necessary to Secure Easy Grades at This Subway. Drainage Is a Problem Here

Highway and Railroad Crossings Were Eliminated by This Structure in Suffolk County. The Long Span at the Right Allows Ample Sight Distance and Future Increase in the Pavement Width

Combination Steel and Concrete Overpasses with Flat Approach Grades

Mine Tailings As Covering

For Asphalt Surface Treatments

By A. F. Reis

TAILINGS from the lead and zinc mines of Joplin, Mo., furnish a very satisfactory covering material for asphalt-treated roads. Large quantities of these mine tailings, popularly known as Joplin chats, are used annually for road building purposes in the country surrounding the mines.

Construction of Macadam. — Between September, 1926, and July, 1927, an 8-in. water-bound macadam surface was constructed on the 10-mile highway between La Harpe and Erie, Kan. A double application of asphalt was made to protect the macadam from moisture and traffic, each application of the asphalt being covered with Joplin chats.

In the construction of the macadam course, sledged stone was set on the sub-base at an angle of 45 degrees. After the tops of the stone had been napped, a 10-ton roller was used to compact the base. Crushed stone, ranging from ¼ to 1½ in. in size was spread and rolled to secure a level surface. Following this, rock dust, consisting of particles passing a ¼ in. screen, was distributed to choke or seal the surface. Sufficient water was then applied to thoroughly puddle the road.

For a few weeks, the project was opened to traffic, as a result of which the stone screenings worked their way down into the base, and some of the lighter material was blown away. This left the broken stone levelling course exposed and ready for the first asphalt treatment.

The First Asphalt Treatment.—Texaco special macadam binder, a heavy liquid material, was applied to the road at the rate of 4/10 gal. per square yard. Over this, a thin covering of Joplin chats was distributed, in order to prevent the wheels of the asphalt distributor from picking up any of the binder.

An asphalt having a penetration of 250 was then applied at the rate of 6/10 gal. to the square yard. Chats were spread over this treatment to a depth of approximately ¾ in., and a light rolling compressed them into the asphalt, producing a mat from ⅝ to ⅞ in. in thickness. Traffic was admitted and completed the ironing out of the road, and for two to three weeks workmen swept loose material over spots in the surface where the asphalt came through.

The La Harpe-Erie road has now been under traffic approximately four years. During that time, no maintenance has been required except for a few spots where tractors and steel-tired vehicles have succeeded in pulling up bits of the mat. This, however, happened in only a few places, where, apparently, a tractor turned around on the road some time during the early life of the surface. Heavy traffic of this kind is quite common on this road, but most of the marks which it leaves are ironed out by subsequent traffic. According to a 1928 census, daily traffic on the La Harpe-Erie road averaged 510 vehicles a day at that time. It has increased considerably since 1928.

Costs.—The costs of building this road may be of interest and are given below:

90,427.7 sq. yd. of waterbound surface at $1.00 per square yard	$ 90,427.70
90,427.7 sq. yd. of fine grading of sub-grade at $0.06 per square yard	5,425.66
67,827.7 gal. of asphalt heated, hauled and applied (including chips) at $0.15 per gallon	10,174.15
Total	$106,027.51

At costs prevailing today the same improvement could now be done for considerably less.

This work was carried out under the supervision of the writer, who was project engineer in charge of construction.

View of La Harpe-Erie Highway in Kansas

Pavement Core-Drilling Practice

A report on spindle speeds, type of shot, design of bits, pressure on drill spindles and miscellaneous factors involved in the choice and employment of equipment

AT the November, 1930, meeting of the American Society for Testing Materials; Committee C-9 on concrete and concrete aggregates, a progress report was presented on the operation of pavement core drills. Since the November meeting the data in the progress report have been augmented by information from several additional sources. In an appendix to the Report of Committee C-9 presented June 26 at the 34th annual meeting of the American Society for Testing Materials, L. W. Teller and P. J. Freeman, respectively, senior engineer of tests, U. S. Bureau of Public Roads, Washington, D. C., and chief engineer, Bureau of Tests and Specifications, Department of Public Works, Allegheny County, Pittsburgh, Pa., summarize and discuss the additional information as follows:

Spindle Speeds.—It appears that spindle speeds of from 50 to 350 r.p.m. are in current use although the majority of operators use speeds of between 200 and 250 r.p.m. One manufacturer states that after considerable experimentation it was found that a linear speed of the cutting edge of the bit of from 300 to 375 ft. per minute gave the best cutting rate and a uniform core. It is also apparent from the data received that, in general, the same spindle speed is used for all materials. The reason for this is that if the spindle is increased for cutting in soft material the steel shot are not kept under the cutting edge of the bit, but are thrown away from it. A few users vary the speed in special cases, such as reducing it when starting the drill in concrete containing especially hard aggregates or when steel reinforcement is encountered. The fact that there is very little range in bit diameters for pavement drilling probably accounts for the lack of data on the most suitable speed for different sizes of bit. The manufacturer who set up the criterion of 300 to 375 lin. ft. for a speed of the cutting edge of the bit reported that he found this to hold for bit diameters of from 3 to 18 in.

Spherical vs. Crushed Shot.—There is a general preference for spherical shot. Various reasons are given for this, as follows:

1. The wear of the bit is considerably greater when crushed shot (or "grits") are used.
2. A greater quantity of crushed shot is required per core than of spherical shot.
3. The cost per pound of crushed shot is much greater than that of spherical shot.

In addition to these statements, which seem to be generally agreed upon, certain operators report other reasons for preferring spherical shots. However, several operators believe that the crushed material is distinctly helpful in starting the bit and in one state which does a great deal of drilling it is reported that "grits" are used exclusively as it is believed that better cores are obtained. The opinion that smoother core surfaces are obtained when crushed shot are used is expressed by several but most of the operators seem to think that the advantages of spherical shot far outweigh the disadvantages.

Thickness of Bit Wall.—Nearly all of the operators have experimented with variations in the wall thickness of the cutting bits and appear to have reached the same conclusion, which is, that if the wall thickness is too great, an unnecessary amount of material is cut away while if the wall is too thin the shot are not held under the cutting edge and the result is unsatisfactory. Bit thicknesses of not less than ¼ in. and not more than ½ in. are being used by all of the organizations whose reports are included in this survey.

Design of the Cutting End.—Quite a variety of designs of this feature are reported. All operators use a slotted bit and all but two use a single slot. The design of this slot varies from ¾ to 2 in. in width, from 2 to 18 in. in length, and from 0 to 45 deg. in angle of inclination (from the vertical). In general, however, the width is about 1 to 1¼ in., the length from 6 to 12 in. and the angle of inclination 45 deg.

Since the function of this slot is to supply abrasive to the cutting edge it would appear that the slot should be wide enough to prevent clogging, particularly at the cutting edge where a fin is apt to form, and should be long enough so that the upper end is at all times above the upper surface of the pavement slab. This will tend to keep the shot from rolling between the side wall of the bit and the core and will feed the shot directly to the cutting edge. Increasing the angle of inclination increases the slot width of the cutting edge without removing additional metal from the slot itself.

Ordinarily these slots are cut with an acetylene torch. One operator welds the ends remaining after the bit has become too short to use, to new bits, thus using every inch of bit length.

Another feature employed by some is to use a cast or sheet-metal cone within the bit to spread the shot and water to the wall of the bit. This cone is free and is placed on the pavement when the cut is started.

Hard vs. Soft-Steel Bits.—There is a general preference for soft-steel bits. The opinion is prevalent that the soft-steel cutting edge soon becomes roughened and this roughness serves to carry the shot along with the bit. In general, the bits are made of steel pipe. One operator prefers wrought-iron pipe and another cast-iron pipe. The latter was old cast-iron water pipe which was available at a very low cost. The former was selected after experiments which led to the conclusion that the wrought-iron pipe (of medium hardness) was better and cheaper than steel pipe.

Pressure on Drill Spindle.—There is a lack of definite data on this item. It is the general opinion that this pressure must be varied with different materials for the most effective operation and that judgment regarding this pressure is essential if smooth cores are to be obtained.

The pressure will also vary with the spindle speed, being less for the higher speeds than for the lower.

In general, it appears that a spindle pressure of about 50 or 60 lb. per in. of core diameter gives satisfactory operation.

Addition of Other Abrasives (Sand, etc.).—Nearly all of the operators have experimented with the use of sand as an added abrasive and appear to have reached the conclusion that sand does not assist but rather re-

tards the cutting rate, except under certain conditions, as follows:

1. In starting the cut.
2. In drilling in materials which do not themselves produce a sludge, such as bituminous filled brick or asphaltic surfaces.

For such drilling, one operator uses one-third crushed shot and two-thirds sand; others use a mixture of equal parts of crushed and spherical shot to which a small amount of sand is added (to which one operator adds a small amount of kerosene).

TABLE I—SHOT SIZES GENERALLY FURNISHED FOR CORE DRILLING

Manufacturer	Manufacturer's Number	Size of Opening Given by Manufacturer, In.
A	6	0.139
	7	0.115
	9	0.088
B	8	0.108
	12	0.093
	14	0.075
	2	0.111
	2½	0.102
	3C	0.083
C	6	0.139
	7	0.115
	9	0.100

It is also reported that for drilling asphalt pavements, nicking the inner and outer faces of the drill bit with a cold chisel and the addition of a small amount of portland cement to the water under the cutting edge greatly facilitates the drilling.

Diamond Drills for Pavement Work.—Those who have attempted to use a diamond drill for pavement work report that they have found it unsuitable and that the cost is prohibitive being many times that of shot drilling. The reason given for the high cost is that the loss of diamonds through breakage is very great.

Other Types of Drills (or Abrasives).—Several operators have tried other materials and none is reported as being satisfactory for pavement drilling at this time.

Miscellaneous.—The time required to drill cores varies naturally with the materials encountered. One operator submits the following data, obtained from observations on the drilling of 111 cores from slabs 7 in. thick:

Aggregate, dense limestone	8	minutes per core
Aggregate, blast-furnace slag	9	minutes per core
Aggregate, siliceous gravel	13½	minutes per core

The amount of shot used varies with the time required for drilling, but appears to be from 1 to 3 lb. per core.

The amount of water required varies widely, the minimum reported being 1 gal. per core.

Steel shot are usually specified by number and this number varies with the manufacturer, as shown in Table I.

It is apparent that the sizes generally used do not vary widely and also that if a particular size is desired it will be necessary to specify a sieve opening.

Highway Transportation Costs

By R. W. Crum
Director, Highway Research Board

How much does it cost to operate automotive vehicles over the public roads? How much does it cost per vehicle mile to provide the highway for their use? How much are the highway users—trucks and automobiles—now contributing toward the cost of the roads they use, and how much should they pay to defray their fair share of the expense? No one yet can say exactly, but upon the answers to these questions depends the development of sound and equitable fiscal policies.

The Committee on Highway Transportation of the Highway Research Board has recently made a notable contribution to the study of these problems. In its 1929 report, the Committee set up the theorem that the actual average annual cost of a highway consists of the interest on the cost to construct, plus the average annual maintenance charge, plus the amount that should be set aside each year at compound interest to produce sufficient money at periodic intervals for reconstruction.

In the report for this year the committee has illustrated the application of this formula by detailed computations of transportation costs for two highways. One is for the section of the Boston Post Road between New Haven and Milford, Conn. This is one of the most heavily traveled roads in New England, carrying upwards of 18,500 vehicles per day. The other road differs very greatly from this one in general physical characteristics and is located on U. S. Highway 65 between Ames and Des Moines, Ia. Here the traffic ranges from 2,125 vehicles on week days to 3,400 on Saturdays and Sundays.

The elements of roadway cost that must be taken into account include: Right-of-way; drainage structures; earthwork; salvage value of prior surfaces; cost to construct the existing surface; signs and other appurtenances; engineering and administration; annual maintenance; maintenance supervision and periodic reconstruction.

The annual costs of these sections of highway per vehicle mile were compared with the taxes per vehicle now imposed and with the vehicle operating costs. The results therefore show the relation between the annual costs of these two roads and the contribution to road funds being made by the users during the year.

The discussion of this report, which was participated in by Professor T. R. Agg, Chairman of the Committee; Professor C. B. Breed, Mr. A. J. Brosseau, Mr. E. W. James, Mr. L. I. Hewes, Mr. J. A. Sourwine, Mr. H. K. Craig and Professor D. P. Krynine, brought out the fact that since the relations between highway costs, vehicle operating costs and taxes upon vehicles and fuel vary widely with the extent to which the particular road is used, the comparisons shown by the report could only be applied to these roads and could not be used as bases for general taxation. However, it was pointed out that by the extension of such methods to a whole road system, average costs might be deduced which would furnish a sound basis for rate-making or taxation.

For further information address the Highway Research Board, National Research Council, Washington, D. C.

Highway Department Completes Quarter-Century.—The Minnesota State Highway Department has rounded out its first 25 years of existence. It was organized in January, 1906.

Scientific Control of Paving Material

Methods as applied at Indianapolis, Ind., and the results that have been obtained—Economy demands encouragement of reliable contractors

By MYRON G. JOHNSON
Assistant City Engineer, Indianapolis, Ind.

VERY few cities have attempted scientific control of paving materials in any way. Its application in its fullest extent to street and alley construction presents problems unlike those encountered in county and highway construction. Its application in the cities in some cases demands a drastic change in the paving industry, as well as a change in the relation of the engineer to the contractor. Indianapolis specifies a minimum strength of concrete, requiring 2,000 lb. per sq. in. compressive strength for foundations of pavements and 3,500 lb. per sq. in. compressive strength for standard concrete pavements before acceptance, and by this method is attempting to control scientifically the paving materials in a practical way. This specification has been in force for the last three years.

Control at Indianapolis.—In determining a definite quality of concrete, a certain value naturally is placed thereon, which in my estimation is eliminating an enormous waste which had taken place preceding the adoption of this specification. Statistics proved that the majority of the loss or waste in not procuring fair value for this product was due to ignorance by all parties in not combining materials properly to secure the highest quality of finished product. The facts presented at this time, regarding the control of paving materials as applied in Indianapolis, are given in relation to high-compressive-strength concrete only. Four or five thousand cylinders have been tested and the results obtained used in presenting this report. The materials are controlled on our paving projects by a practical method, requiring practically no additional equipment other than what is used on most paving projects in the country.

The results obtained were secured by assisting the contractor educationally in procuring high-strength concrete. Much of the credit for the results obtained during the last three years must be given to our city civil engineer, A. H. Moore, and the testing laboratory, under the supervision of C. H. Underwood and his assistant, A. S. Burns. Both the laboratory engineers, being very capable regarding proper control of materials in concrete, have always aided the contractor in eliminating defects or poor workmanship resulting in defective concrete. All materials have been tested and all cylinders molded as recommended by the American Society for Testing Materials. Cylinders were cured in the laboratory 28 days before testing up until last year, when contracts were accepted providing 14-day tests were above the minimum required. The progress made in securing better concrete in Indianapolis, during the last five or six years, will be outlined by giving test results and general procedure. During the years 1925, 1926 and 1927, molded concrete cylinders were completed as the work progressed on all projects and later tested for compressive strength. The defective cylinders were analyzed and the engineers immediately investigated the conditions on these particular projects and ordered necessary changes to eliminate the failures if possible. A continual check was made on these concretes until the quality of the concrete was satisfactory. No specified strength was required during these three years and the testing reports served merely as a source of information to the engineer as to quality of concrete being produced. However, during these three years, numerous changes were made regarding specifications and contractors were educated as to the importance of water control, proper proportioning and proper grading of materials. The old chute-type mixer became obsolete and accurate measuring devices were insisted upon. Strike-off batches and timers were required on all types of mixers.

Results of Early Tests.—The results obtained from tests completed during the years 1925, 1926 and 1927, when strength was not specified as compulsory in the specifications were as follows:

Average compressive strength of all cylinders tested for concrete foundations was 25 per cent over the minimum which is required today; 32 per cent of the cylinders were below the minimum.

The average compressive strength of all cylinders tested for standard concrete pavements, including alleys, was 10 per cent under the minimum now required.

Results After Minimum-Strength Requirement Was Adopted.—During the year 1928, specifications were adopted requiring minimum-compressive-strength concrete on all paving projects before acceptance; these have since been in force. The following results show an enormous increase in the quality of concrete placed in the city streets of Indianapolis during the last three years. The average compressive strength of all concrete tested for foundation is now 40 per cent above that required. The percentage of cylinders which tested below the minimum now required is 5½ per cent. The average compressive strength of cylinders representing standard concrete pavements, including alleys, is now 20 per cent above the minimum now required, and the percentage of cylinders tested which were below minimum required, is now but 8 per cent.

It seems hardly possible that such an increase in the quality of concrete could take place without any increase in cost whatsoever to the contractor. Although the laboratory engineering force and equipment was increased, it is not difficult to estimate the enormous dividends the city laboratory has paid the taxpayers during the last three years. Upon analyzing the yearly reports, it is remarkable to note that the compressive strength of concrete being placed today specifying 1.18 bbl. per yard is as high as the concrete produced in 1927 which specified a mix of approximately 1½ bbl. to the yard. This remarkable progress is due to elimi-

nation or modification of the following practices, which were in the past very prevalent, and which were the most serious: the use of all fine or quicksand in the mix in place of concrete sand, the sloppy mix, dirty or unsatisfactory grading of coarse aggregate, allowance for bulking of sand, adjusting the mix for workability.

Before specified-strength concrete was required on contracts, the engineering department held the sole responsibility for the acceptance or condemnation of materials used. If it was impossible for the department to approve or condemn it, it nevertheless entered into the concrete, and its quality remained an unknown quantity indefinitely.

At the present time the approval or rejection of materials has become an inherited problem for the contractor and the material man, who now insists that proper materials be delivered to the project. The contractor has become more interested in the entire construction of the slab, in general, as well as the material man, and in so doing has raised the standards of his organization, as well as those of the material man, which is naturally beneficial to both.

Payment Based on Quality.—Pavements are not accepted until test reports are submitted to the engineer, designating the results. Sections of pavement showing deficiency in compressive strength, are considered unsatisfactory and a reduction in price per square yard of this section is made in proportion to the deficiency. In other words, the contractor is paid for the quality of his product, for value received, regardless of cost. The molded cylinders are taken at frequent intervals, as often as 6 or 8 times daily, depending upon the speed of the contractor, the size of the project and the efficiency of his organization. When the test reports covering molded cylinders indicate serious defects, the core drill removes additional cylinders which are tested, and a complete check is made of the pavement before acceptance. The testing laboratory also keeps the engineering department well informed as they visit the projects, as to the quality of concrete being produced. The engineering department analyzes the quality of the contractor's product that, when cylinders are questionable, he may adjust his mix and eliminate his trouble at once, before a serious deduction could be possible. It is not difficult to assume what an increase would now take place in the strength of concrete if scientifically controlled at an efficient plant set-up.

Control at Central Mixing Plants.—Indianapolis today is about to adopt an alternate specification to control scientifically the paving material at central mixing plants, if established, requiring specified-strength concrete through cooperation with the contractor, and scientific preparation of the mix for a definite quality or value to be received. Other cities are gradually adopting the practice of scientific control of paving materials through central mixing plants and are distributing the scientifically prepared product to the individual project. At present, the method and cost of transit seem to be the controlling factor as to its practicability. There is no question but what a higher quality product can be produced at less cost at a scientifically controlled plant, than on the project.

This change in the paving industry places the contractor as a producer or manufacturer of a marketable product, and I most certainly would recommend that the cost of this product depend entirely upon its quality as delivered, providing at all times it is of workable character to complete a satisfactory pavement. His ability as a manufacturer in producing this product surely would also determine his cement content, as well as the material content, depending also upon the quality of the materials entering into the mix; in other words, specify the quality regarded only as constant.

At the present time, no consideration whatsoever is given the contractor whose concrete is a better product than that of his competitor. It would seem that the irresponsible contractor could soon be eliminated and the efficient, reliable contractor would be rated as to the quality of his product and receive all benefits to which he is rightfully entitled. Since the value of this product today is not a deciding factor, the responsible, efficient manufacturer or contractor can do nothing but pray that his honesty, ability and financial standing may influence the officials to award him the contract, even though he is a higher bidder. The average contractor with a standard paver is producing today approximately a cubic yard of concrete every one or two minutes while in operation. No one can legitimately dispute the fact that it is gross negligence to manufacture such a product at a cost of from $300 to $500 per hour and place a supervisor over its production, someone who merely has been told that cement, sand and gravel of a certain mix combined, produce good concrete. It certainly is practical and efficient to produce information to prove in some manner a fair value for such an expensive product before it is ready for service. If a specified mix should without question produce a product having a certain strength or load capacity and no evidence is produced showing that it will carry even half its proper load, it is most natural to assume that a financial loss is taking place. Every paving engineer and contractor who is truly interested in this great industry, should demand scientific control of street-paving materials in some manner or other to insure value received and raise the standards of the engineering profession, as well as the paving industry. If a commercial manufacturer under average conditions were to market a product of as great a value as concrete, and give as little attention to its quality or value as in some paving projects, his industry would soon pass out of existence.

Conclusions Summarized.—As a summary the following conclusions are predominant: Scientific control of street-paving materials results in predetermined strength of concrete and higher quality at less cost. Predetermined strength of concrete results in predetermined economy as well. However, this economy in adopting scientific control of materials can only be predetermined when a specified strength is required. The advantages then appear on the cost sheet, otherwise the increase in life of the slab or ability to withstand more than for what it was designed, are the only advantages to gain and which can only be estimated.

Acknowledgment.—The foregoing is a paper presented at the 17th annual Purdue Road School.

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VERTICAL CURVES.—The minimum standard sight distance on vertical curves on state highways in California is 600 ft.

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CURVE WIDENING.—Curve widening is applied to all curves on the state highway system in California with radii of 500 ft. or less.

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ROADS IN THE ARGENTINE.—Argentina has 131,697 miles of road at the present time, of which about 500 miles are hard-surfaced.

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443 MILES OF FENCE.—The Pennsylvania Department of Highways completed erection of 433 miles of new guard fence along highways during the past two years. Erection of the new fence and maintenance of all guard fence cost $1,200,000 in the period. The work required 229,000 choice posts and 866 miles of cable.

EDITORIALS

Sandpapering Backslopes

SEEMS high time that highway engineers ask themselves this question, "Why do we require such fine sandpapering on the backslopes of our cuts?"

The added advantage to be gained by such smooth surfacing of backslopes is not worthy of the expense incurred. After the first rain the beautiful backslope is all cut up and the labor of smoothing lost. While it may be difficult to define the tolerance to be allowed by specifications, it would not be hard to instruct inspectors as to the backslope finish. A finish that is in keeping with ordinary machine grading should be good enough on a backslope on any cut.

To give the looking glass finish required by present standards requires the continual labor of two or more men during the course of a grading operation. As truly as these remarks apply to backsloping may they also be applied to shoulder work.

It is inevitable that automobiles will drive off onto the shoulder during or shortly after a rain. In fact, some states require that cars must drive off the surfaced roadway if they intend to stop. What happens to the smooth, sandpapered shoulder? It becomes rutted and rough, not only from the automobiles but also from the rain itself. We should be more tolerant in our specifications on this point. Money spent for the close work required at present is simply washed into the ditch.

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To Reduce Postal Deficit Build More Roads

"THE rural carriers of the United States must accept the postal deficit as one of its own problems and must use every resource at its command to attempt to harmonize that postal deficit with a genuine necessity for a larger net income . . ." John J. Shinaberger, President, East. Dist. Oklahoma Rural Letter Carriers Assn. From this statement it is plainly evident that although a rural mail carrier may get a stipulated sum of money for his services, he has to expend various amounts to accomplish the service, thus producing a variable net income to himself. Like all the rest of us, he is striving to improve his economic condition. To do this in the face of a large postal deficit requires courage and attention to those items of expense that cause the largest drain on his income. Transportation on his route is the largest individual expense.

The rural letter carrier is not alone in recognizing that transportation costs are one of his most important economic factors. This same question has been recognized during the past year as a very potent factor affecting the much sought farm relief. It is now becoming fairly well recognized that the farm to market road is a very necessary link in our national life. It happens that it is these same farm to market roads that the letter carriers use most. They would do well to use their combined effort in promoting improved low cost county and township roads. In fact, this activity should be sponsored by their national association. No other single activity of their association could strike at the root of their economic trouble, the low net income, more effectively than to bend their energies toward improving their routes. No other program would enable the rural carriers to assume greater mileage even to the point of absorbing many existing star routes, at less cost to the department. No other program would permit the rural carrier to request the elimination of many small offices where duplication of services is now rendered and thus eliminate a departmental expense without increasing the hardships of the rural carrier himself.

For the Rural Letter Carriers Association to tackle such a comprehensive task for the promotion of road building may at first sight seem out of the picture. It is not, however. It may be a difficult task to accomplish but with their influence, scattered throughout the entire rural and agrarian population of this country, guided by a central power, they can become a tremendous force in helping to solve the economic problems of both the carrier and the department.

One of the greatest aids in reducing the postal deficit is the construction and maintenance of more low cost county and township roads.

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Present High Cost of Thrift

ON EVERY hand we hear and see the statement, "Buy Normally." The purpose of this statement is to encourage our people to spend now as they would in a normally prosperous year. By so doing we can restore business and ward off further inroads on our total income which the "depression" is causing today.

In other words, the habit of frugality and thrift is costly during a time like the present.

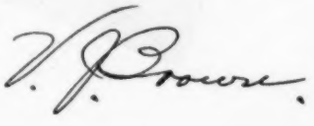
Only too willingly would the mass of the people "Buy Normally" if they could. But they keenly realize that every cent they can muster is yet not enough to give them the standard of living they should have, thus causing lack of spending. Fear that part of the capital now possessed by those who have it would be lost should they venture into a business enterprise at this time is a cause of thrift or saving on their part.

Continuance of this attitude on the part of both capital and labor simply prolongs the "depression" and causes more lost income.

These humanistic forces must be overcome and courage injected into our business executives. Courage comes through a knowledge of the situation and knowing how to cope with it. For this purpose, economists and statisticians have devised gauges for determining the trends of business. These latter are dry, inanimate market facts logically arranged and presented.

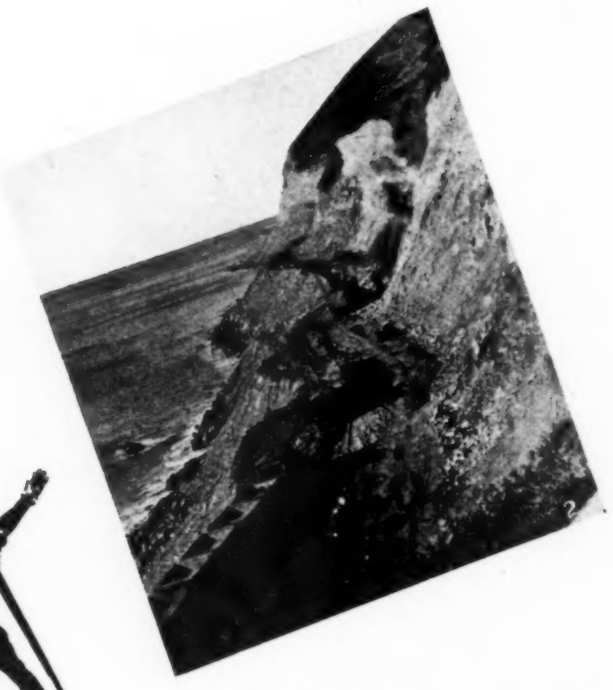
"The inanimate economics of prices and production is an interesting and engaging subject, even to the layman, but it has not yet been successfully correlated with the dynamic economics of men and their emotions."—[Editorial—Iron Age.]

With the fall in prices which accompanies a depression came the resulting retrenchment in buying. This retrenchment will be overcome only when and if purchasing normally resumes. Buying in normal volume can never be accomplished so long as fear prevents prospective business from being registered as orders. During these times of high cost of thrift it seems that it is well to remember that the driving force of business, after all, is the courage and initiative of the business executive.



HIGHWAY ROMANCE

Ipso Facto



Whin you want to build a highway 'long the mountain cliff or plain
Where there's niver annyboddy bin before,
Why you call on Leather Leggin's and he hitches up his belt,
An' he takes it as his ordinary chore
To go blastin' thru the rock cliffs where the soarin' eagles thrill,
An' the lazy snakes are hissin' down below,
Or to drag a chain an' transit over gulch and jagged hill,
As he marks the route the right av way will go!

Leather Leggin's
With Apologies to
Berton Braley

Whin you need to cross a river with a roadway on a fill,
Or to tunnel underneath it in the mud,
Or to bore and blast the highway thru the innards av the hill,
Or to blow aside a mountain with a thud;
Whin you want to bridge a canyon with your road straight as a string,
An' the cliffs is steep an' smoother than a wall,
Why you call on Leather Leggin's an' he does that little thing
An' then comes 'round an' asks you, "Is that all?"

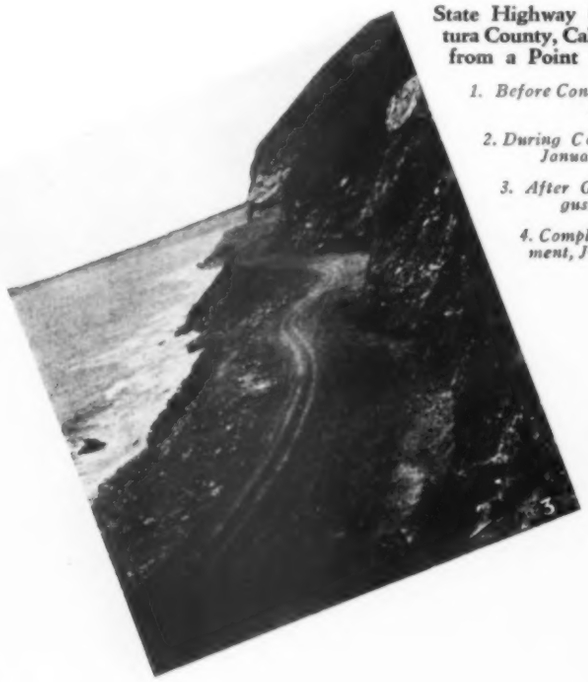
State Highway Coast Route, Ventura County, Calif., Looking West from a Point Near Hueneme

1. Before Construction, August, 1923

2. During Construction, January, 1925

3. After Grading, August, 1925

4. Completed Pavement, June, 1929



County and Township Roads

Michigan Legislates Township Roads *Into County System*

By J. W. HANNEN
Editor of Michigan Roads and Airports

IN the firm belief that two units—the state and the county—can better construct and maintain the roads of Michigan than with the additional 275 units represented by the townships of the state, the state legislature of 1931 enacted a law providing that approximately 50,000 miles of township roads shall be taken over into the county road systems during a period of five years, beginning in 1932. This act is universally regarded in Michigan as one of the outstanding pieces of legislation adopted at the 1931 session.

As in every other state, the burden of taxation is the foundation of an appeal to the state legislature for property tax relief, and the McNitt-Holbeck-Smith bill affords an immediate relief in 1932 of $2,000,000 from state highway department resources, increasing each year $500,000, until at the end of five years all of the township roads shall have been taken into the county road system.

In Michigan more than $8,000,000 has been raised in townships for township road improvement, the major portion of which has been for repairs without any possibility of permanence.

Property tax relief is the universal cry throughout the country and the Michigan legislature this year was flooded with appeals from all parts of the state demanding a reduction in property taxes. To meet this demand numerous propositions were introduced by bills. Among these was a sales tax measure calculated to hit the chain stores. Another, an income tax law, which was bitterly fought by the manufacturing centers. Another was in the form of three measures directed toward a diversion of $7,000,000, to cover a period of two years, from the motor vehicle weight tax now used by the state highway department for road purposes only. All of these bills were defeated.

The measure providing for diversion of state highway funds into the general fund was bitterly fought by the four road organizations of the state, the two major associations being the Michigan State Good Roads Association and the Michigan Association of Road Commissioners and Engineers. The two other road organizations, of regional activity, joined in this opposition. The combined opposition of these organizations defeated the proposal to divert any funds from state highway resources to other than road purposes.

While there is still a determined effort on the part of certain real estate interests calculated to eventually bring about such diversion, the enactment of several laws involving state highway activities is expected to result in direct tax relief upon property, which is the end sought by the proponents of the highway finance diversion proposition.

Outstanding in this respect is the McNitt-Holbeck-Smith law, which provides as described that all of the township roads of the state shall be taken into the county road systems at the end of five years, at which time $4,000,000 annually will be taken from the state's highway resources represented by the gasoline tax of 3 ct. per gallon and the weight tax upon motor vehicles. The gasoline tax yields annually in excess of $21,000,000, and the weight tax approximately the same figure. In 1930 the total realized from these sources was more than $43,000,000. Of this amount approximately $22,000,000 is obligated by provisions of the Legislature, i. e., $4,082,000 annually to go into the sinking fund and to pay interest on the $50,000,000 bond issue passed under a constitutional amendment in 1919. This entire obligation will be discharged in 1944. Another fixed obligation of approximately $10,500,000 is returned from motor vehicle taxes to the counties of the state, totaling in 1930, more than $10,500,000. Maintenance provided for by legislative act the same year was in an amount in excess of $6,000,000. These items, together with the cost of administration and operation of the state highway department, brings the total to more than $22,000,000 annually.

The taking over of township roads by the counties is a proposition that has been under universal discussion throughout the country, as it is conceded that a county unit, represented by the county road commission with its engineering department and adequate equipment, can maintain and improve township highways at much less cost than can be done under the authority of township highway commissioners. These officers are elected every year in many counties, and in others, every two or three years. It is common knowledge that, with very few exceptions, these township commissioners are men of inadequate experience in road maintenance and improvement, hence it is held that the cost of township road improvement has been excessive and can be re-

duced nearly if not quite one-half by organized operations of county road commissions. It is therefore believed that the $4,000,000 annually will accomplish nearly if not quite as much as the $8,000,000 now raised by the townships throughout the state.

It is true that many townships in the more thickly populated counties have experienced highway officials, but in the great majority of counties this is not the case.

The McNitt-Holbeck-Smith bill provides specifically that the amounts paid by the state highway department shall be devoted to maintenance and where there is any excess over maintenance requirements the same shall be devoted to permanent improvements, such as grading, drainage, and other essential requirements. In some townships of the state it is permitted by law to raise a ten mill tax, according to valuation. Under the McNitt-Holbeck-Smith law the township is limited in 1932 to five mills, in 1933 to four mills, and thereafter not to exceed three mills. These millage taxes, it is understood, are to be devoted to improvements rather than maintenance.

In the matter of improvements the law provides that the county road commissions may prepare a program of roads to be improved, to be approved by the state highway commissioner, and that the same shall be submitted to the county boards of supervisors, and by them submitted to the township officials. The extent of improvements made on township roads is therefore to be determined by the county road commission, the supervisors and the township officials, thereby allowing the townships a voice as to the amount of money they shall raise for construction.

Preliminary to the payment of the funds described from the state highway department resources, a complete survey shall be made by the department immediately upon the taking effect of this law, to ascertain the township highway mileage in each township in the state as of Jan. 1, 1931, exclusive of streets and alleys in recorded plats, unless said street or alley shall have been laid out as a public highway prior to the recording of such plat and not later than Sept. 1, 1931.

The state highway commissioner shall certify to the board of supervisors and the board of county road commissioners of each county as to the total township mileage for each township in the several counties, together with the total of such mileage for each county. In Michigan each township of every county elects two supervisors to the county board. This board is the governing body of the county. The Board of County Road Commissioners has executive charge of the construction, improvement and maintenance of highways only. In some counties members of the County Road Commission are appointed by the Board of Supervisors, in other counties, elected at large, either system being optional. On or before April 1, 1932, the board of county road commissioners in each of the several counties shall take over and incorporate into the county road system 20 per cent of the total road mileage of the townships so determined and fixed by the state highway commissioner for each township in their respective counties. Thereafter the board of county road commissioners shall on April 1 of each succeeding year, take over and incorporate into the county road system an additional 20 per cent of such township highway mileage, until the entire township highway mileage in all of the townships of the counties shall have been taken over and made a part of the county highway systems.

In the year next following the taking over of such highways, all dedicated streets and alleys in recorded plats and outside of incorporated cities and villages shall be taken over and become county roads.

A survey by the state and reports from boards of supervisors indicates that the township officials are willing to co-operate in bringing about the provisions of the act.

It is conceded that the law is not 100 per cent perfect but it was framed after a dozen or more conferences sponsored by the Michigan Bureau of Highway Education, and it is believed to be as nearly equitable as any law that could be devised until after a practical trial. In framing this law the Highway Bureau called in representatives of the Michigan Association of County Supervisors, the Michigan State Farm Bureau, the Michigan Association of Rural Letter Carriers, and Michigan State College, and it was after many conferences that the principle and general provisions of the act described were determined upon as the background of a law to meet the desired ends, and it is significant that the members of the legislature, both House and Senate, commended the activities of the Michigan Bureau of Highway Education, and the law was passed by both Houses, practically unanimously. While this law is conceded to be one of the outstanding highway acts of the Michigan Legislature it is expected that amendments will be offered at a special session, but on the whole, the measure is universally regarded as a step in the right direction.

Another law sponsored by the road organizations is known as the Dykstra bill. A bill drawn by Representative Dykstra two years ago provided that one-third of the motor vehicle weight tax be diverted to cities to use at will, one-third to the state highway department, and one-third to villages and townships. This bill was backed by the Michigan League of Municipalities, but was fought by the road organizations of the state with success, and Representative Dykstra changed front and introdduced another measure for participation by the state highway department in maintenance and improvement of trunk lines within municipalities. This participation is to be graded. In cities of 50,000 or more population the state highway department and the municipality shall share on a 50-50 basis. In cities of 45,000 population the participation by the state is 55 per cent, and so on, the ratio of participation by the state increasing until in the case of cities of 5000 or less the state shall bear the entire cost of paving to a width of 20 feet. The same ratio of participation of cost applies to bridges within municipal corporations. In the matter of railroad grade separations the railroad shall bear one-half the cost, the other half to be equally divided between the state and the municipality.

This law legalizes a practice which in a measure had already been established by the state highway department, specifically in the cities of Detroit and Grand Rapids. In the former city the state in 1930 made a contract with the city of Detroit to participate in the widening and maintenance of trunk lines to the extent of $3,200,000 a year for a period of five years. A simliar contract had been made with the city of Grand Rapids for approximately $1,000,000, both on a 50-50 basis. These contracts were made because it is conceded by the state that inasmuch as these municipalities pay a large amount of the gasoline and weight tax they are entitled to aid from the state in widening and construction of trunk lines passing through their corporate limits.

It is estimated that this will require the expenditure by the state of approximately from $5,000,000 to $7,000,000 annually, and it is because of the provision for

township road relief and participation in trunk line improvement through cities that the opposition to the diversion of state highway funds to the general fund was so vigorously carried on. This attitude is in line with the position held by the American Association of State Highway Officials and the American Road Builders Association, upon the ground that all funds raised by motor vehicle taxation shall be devoted to no other purpose than the construction and maintenance of highways.

Another measure passed by the legislature provides for improvement of railroad grade crossings by which the railroads are required to improve between rails with the same type of construction as that upon the highways. The law also provides for the removal of obstructions to vision and for installation of warning signals.

The Covert Act, also, provides for laying out assessment districts for Assessment District roads, the cost being assessed according to frontage. The law provides for bonding such districts for highway construction.

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Conner Advocates Low Cost Bridges on Low Cost Roads

Economizing on bridges and culverts to lower road building costs was advocated in a discussion of low cost bridges by C. N. Conner, engineer-executive, American Road Builders' Association, at the annual highway engineering conference of the University of Michigan.

The highway engineer and his public, he declared, are well sold on the utility of low cost roads.

"For complete economy," Conner said, "low cost roads should be of low cost throughout, and the question of economizing on bridges and culverts offers a fertile field for real savings in first cost and in net cost over a period of years.

"Low cost roads should have low cost bridges unless expected traffic will reach the volume which exists on primary or trunk highway systems. Even then a progressive type of bridge construction may be advisable if funds for initial construction are low.

"In no field of highway work are skill and judgment more essential than in bridge design and construction," he declared.

The term cost as applied to highways was defined as the cost per mile for owning and operating a highway, plus the cost of owning and operating vehicles over it. An acceptable low cost surface was suggested as costing less than $10,000 per mile for an 18-ft. surface width which might be traveled in safety and comfort at a speed of 45 miles per hour.

Low cost bridges are tentatively defined as those costing at first, for a 20-ft. roadway, less than $100 per lineal foot for long spans, and less than $50 per foot for short spans. Salvage value of bridges must always be considered, and the type of structure must be properly selected. For example, through girders and trusses are not generally adaptable to widening, while deck structures are. Steel superstructures may be salvaged and used at new locations when necessary. Many old steel structures, if given half a chance by adequate repairs by arc welding, would have their useful life greatly extended. Timber substructures of treated piling were declared to be low in first cost, of long life, and if abandoned, the loss of investment would be small. Timber and steel structures have an additional advantage in that they may be erected.

"During the past ten years," Conner declared, "because highway traffic has increased enormously, we find that structures must be widened, rebuilt, or abandoned to ease up on approach curves or lengthen vertical curves. Traffic may be reasonably expected to increase during the next several decades and it would be a daring prophet indeed who would attempt to set limits on this development.

"Under these conditions it would seem advisable to design substantial structures which could be altered for future traffic requirements with minimum expense. Extra expense for aesthetic appearance cannot be justified on development roads, especially when substructures are not visible to the autoist. Obsolescence is always more costly than maintenance, and an attempt to provide very far into the future for traffic changes, and to build expensive structures when low cost structures will suffice, may be a grave risk of highway funds."

Bridge types favored by Conner because of salvage value include those of steel construction or creosoted timber with floors of either wood or concrete, preferably the latter, this type having proved very satisfactory and economical in several states. Rigid frame design and construction for concrete, one of the latest developments in structural engineering, is used by some designers in order to take advantage of every economy in design. The continuous beam type, using 36-in. I-beams, is becoming more popular, and some 10 per cent may be saved by designing for continuity instead of simple spans only.

"Economy may be saving or it may be spending," Conner concludes, "whether a structure of steel, concrete, stone, wire or combinations thereof will prove to the best advantage over a period of time will depend on the appraised value of first cost, salvage value, appearance, assumed life, and cost of maintenance."

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Bridges Should Be Built to Full Width

"It is false economy to build bridges too narrow for the safety of modern high speed traffic and culverts should be long enough so that the traveler does not see them as he passes," says H. G. Shirley, vice-president of the American Road Builders' Association.

"For safety, all bridges should be at least as wide as the traveled way. Through bridges that have trusses on either side to support the roadway are not easily widened. There is a tendency among engineers, where conditions warrant, to build deck bridges with the floor on top of the trusses so that the roadway can be easily widened. For smaller bridges, deck construction with beams instead of trusses is used.

"Culverts should be long enough to be unnoticed by the traveler as he passes. They should be large enough so that the land along the road will not be flooded. Culverts are built for utility and decorative headwalls are usually out of place and a menace to motor drivers."

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Numbering the 300 miles of Ionia County's roads in Michigan was recently completed; 900 route markers were used. Distance and direction signs are also to be erected.

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GRADE SEPARATIONS LANDSCAPED. — Right-of-way areas at railroad grade separations on California state highways are scheduled to be landscaped. Slopes and approaches at nine locations were planted in the spring of 1930.

Wide Roads at Low Cost

Wide roads can be built at low cost by using modern methods of surfacing declared Otto Hess, engineer-manager, Kent County Road Commission, Grand Rapids, Mich., in a report on low cost roads and bridges made by the American Road Builders' Association.

"It is a mistaken idea that roads must have a narrow surface in order that a large number of miles may be built," asserted Mr. Hess. "By the application of the principles of stage construction in the selection of surfaces to fit the traffic, a road may be built like the 'wonderful one-hoss shay' with each part proportioned to the strain of traffic that is to be placed upon it. Widths that permit safe and comfortable passing at any speed are not expensive with low cost surfaces.

"Where traffic conditions do not demand a high type of surfacing," he continued, "low cost surfacing of roads that have been properly located to eliminate sharp curves and provide adequate sight distance is economical and permits widths adequate for safe driving."

The steps in low cost road building for two lanes of traffic (20-ft. width), states the report, are (1) selected soil surface, (2) traffic bound surface, and (3) bituminous surfaces. Greater width can be added to all of these surfaces at a relatively low cost.

The report further states that selected earth surfaces may be constructed at from $1,300 to $2,600 per mile with $300 to $600 per year allowed for maintenance. Such surfaces will accommodate from 100 to 500 vehicles per day with few trucks and no heavy trucking in wet weather.

Traffic bound surfaces will cost from $2,000 to $3,000 the first year, $1,000 the second year and from $500 to $800 per year thereafter. Traffic of from 300 to 600 vehicles per day can be accommodated including trucks except when freezing and thawing occur.

Bituminous surface applications cost for construction from $1,000 to $3,000 per mile; mixed-in-place asphalt or tar surfaces from $1,000 to $5,000 per mile; and premixed asphalt or tar surfaces from $5,000 to $10,000 per mile. Maintenance costs per year are: surface applications, $200 to $700; mixed-in-place, $200 to $700; premixed, $200 to $500. Such surfaces are adequate for from 1,000 to 2,000 vehicles per day including trucks on pneumatic tires.

"The importance of adequate width in reducing accidents and permitting comfort and speed in driving," concluded Mr. Hess, "cannot be too strongly emphasized."

Group of County Officials (A. R. B. A.) Taking Trip Over Wayne County, Michigan, Highways. This Preliminary Meeting Made Arrangements for Receiving County Officials Attending 1932 Road Builders' Convention

The More People the More Roads

The mileage of highways in different sections varies with the population of the section—the more people the more roads. This fact seems to be as it should be; it is only when not enough roads are provided for the people that congestion on the roads becomes troublesome.

The mileage of roads in various sections seems to average about as follows:

	Miles per Square Mile Area
Municipalities	20
Metropolitan areas	10
Rural manufacturing areas	2.3
Agricultural areas	1.7
Mountainous areas	0.7
Desert areas	0.3

In the United States, populous states like Connecticut and Rhode Island have about 2.5 miles of highway per square mile while agricultural states like Illinois, Iowa and Missouri have about 1.7 miles per square mile of area. Pennsylvania and Ohio have about 2.0 miles per square mile.

In foreign countries, France has 2.1 miles per square mile and England has 2.6 miles per square mile.

Of this mileage a small part is highly improved and carries the greater part of the traffic—15 per cent of the roads bear 70 per cent of the traffic—while by far the greater mileage is used as feeder roads to convey traffic from many farms and villages to the main paved roads. In France the national roads are 5.7 per cent of the total mileage; in England 18.7 per cent, according to E. W. James of the U. S. Bureau of Public Roads. In the United States, the various states have from 9 to 14 per cent in the state main road systems. Federal aid roads are limited to 7 per cent of the total mileage of each state.

Studies of traffic volume and the planning of roads for both populous and sparsely settled counties have been made by the American Road Builders' Association and these studies are available to road officials.

While the United States has about 3,000,000 miles of roads, only a very small part of this mileage, about 660,000 has been improved with surfacing. Many of these surfaced roads must be widened and otherwise rebuilt to provide for the heavy automobile traffic that is continually increasing. There is a tremendous job of road building ahead for the United States.

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In Texas

I know right from wrong; and our present system [of financing state highways] is dead wrong. In fact, our Revolutionary forefathers went to war for less discrimination in taxes than we have on our State highways.—Oscar C. Dancy, County Judge, Cameron County, Texas.

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An estimated saving of $40,000 resulted from the cooperative purchase of 2,820,000 gallons of road oil by twenty-one townships of Sangamon County, Illinois. This purchase was arranged by the county superintendent of highways and the county road and bridge committee.

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Now and then a community wakes up and discovers that it cannot get everything it should have without raising the taxes.—*Santa Rosa Press Democrat.*

Low-Cost Road Research Problems

Many Questions Need to Be Answered States R. W. Crum, Director, Highway Research Board

CONSIDERING the enormous expenditures that need to be made for secondary and tertiary highways, it should not appear strange that our research bodies are overcrowded with pressing problems. With the advent of the motor vehicle, it is impossible for researchers in the highway field to put these many problems behind them. One thing they can say, however, is that they now realize more nearly what are the most pressing problems. Mr. Roy W. Crum, Director of the Highway Research Board of the National Research Council, gives the following analysis of some of the problems confronting engineers and taxpayers:

I remember an Iowa farmer who became much exasperated over the waste of the taxpayer's money as evidenced by a party of surveyors who operated along his road for some time. He went to the county engineer and demanded to know the reason for the foolishness. "Why," said the engineer, "they have to get the data so that the road can be properly designed." This was too absurd for the old man. "What," he said, "is there to design about a road?" I suppose he would be even more astonished at a need for extensive research on low cost roads, but I am sure all highway engineers will agree that the solution of the farm to market road problem is the most difficult and pressing problem of all.

How Is Money to Be Raised to Pay for These Roads?

The general problem is the equitable distribution of the cost of providing highway service in proportion to the benefits derived therefrom. It may be assumed in the case of secondary roads that benefits accrue in three ways: (1) General benefit to community life; (2) Special benefit to abutting property, and (3) Benefit to the individual user of the roads. Revenues should be raised from each of these three sources, the unanswered questions being: "What portion should each source contribute, and in what ratio should the funds be allocated among—the through traffic highways, the community roads, the purely local roads, and municipal streets?"

I—General Taxation.—To what extent should the general public contribute through property taxes, and what proportion should be expended upon each of the three classes of roads—(a) through traffic highways, (b) community roads, (c) purely local roads? In other words, to what extent should property taxes be levied in the interests of each of the three classes of roads? On the one extreme we have the local road of importance only to the residents along the road, used only by them or by those who seek access to them. On the other extreme we have the through highway used by everyone in the community as well as by others from outside passing through. To what extent does the improvement of each of the three classes of roads benefit the entire community irrespective of the actual use of the roads?

Research Needed.—1. Studies of economic changes in typical communities to show the benefit of road development in the life of the community.

2. Studies in typical communities to show the stage of road improvement at which the benefits to the road user begin to overshadow the general benefits. For instance, a low type of surfacing might be sufficient for general community needs, although a high type may be needed to care for the traffic adequately.

II—Assessment Against Abutting Property.—Agricultural property is undoubtedly benefited by proximity to a good road over which its produce can be marketed and also to some degree by the effect of the road improvement on its desirability as a home site. The question is, at what stage in road improvement does the special benefit cease to increase? These benefits can be measured by the increase in selling price of the land caused by the road improvement, and in the absence of such cost data by farm records as to cost of marketing and savings due to timeliness in marketing.

Research Needed.—1. Studies in a number of scattered communities of the effects of different types of road improvement upon land values and marketing conditions, and the effect which distance from marketing centers has upon land values, and upon the type of road necessary for that service.

III—Motor Vehicle Taxes.—Taxes imposed upon vehicles are of three kinds at the present time. (1) General property taxes. (2) License and registration fees, and (3) Taxes on gasoline. It may be assumed that the most equitable taxes on the vehicle are those based upon the amount of use of the road and upon the destructive effect of the vehicle upon the road. The tax on gasoline is the best measure yet proposed for a tax based upon use of the road. The destructive effects of different types of vehicles have not yet been evaluated. Information is needed as to the costs of vehicle operation and as to the costs of providing highway service adequate for different classes of traffic. For instance, a six-inch concrete slab might be heavy enough for a large part of the traffic on a certain highway, but the presence of bus and truck traffic might make necessary an eight-inch slab. In such a case a tax rate based on mileage alone might not distribute the burden equitably. On the other hand it might not be equitable to saddle all of the cost of the extra 2 in. of concrete upon the busses and trucks because the public benefits from the ability of the busses and trucks to operate over the road.

Another problem of immediate importance is the distribution of the proceeds of gas or other vehicle taxes, as between the various classes of rural roads and city streets. If such taxes are a measure of road use by

the vehicles, all of the roads used have some claim upon the proceeds of the tax, but as yet no data are available showing what the relative amounts should be. The proportion of a gasoline tax, for instance, that should go to the various classes of roads, and to the city streets will depend upon the relative amount of traffic and upon the proportion of the cost of each class that should be borne by the road user.

Research Needed.—1. Vehicle operating costs, for various types of vehicles, on various kinds of road surfaces.

2. Costs of providing highway service for various kinds of traffic. (Note: These will be further discussed under Highway Transportation Costs.)

3. Relative use of different classes of roads. Traffic surveys on all classes.

IV—Use of Credit.—If roads are constructed by means of bond issues, they can be put into service sooner, but the earlier expenditure of capital will mean additional interest charges which will increase the net annual cost of providing the highway service. The question is whether or not the savings in total highway transportation costs during the extra years of service will compensate for the additional roadway cost. The answer to this in any given case will depend upon the available knowledge of costs of transportation over various types of road surfaces and upon the amount of traffic.

Research Needed.—1. Data on highway transportation costs. (Note: To be further discussed under Highway Transportation Costs.)

2. Several states having already financed road improvement programs through bond issues, studies of economic conditions in those states as related to highway transportation should go far to answer the question as to the practical value of thus speeding up the road building program.

What Will the Roads and Their Use Cost?

Highway Transportation Costs.—The annual cost of transportation over any length of highway consists of the yearly cost of providing the roadway ready for service plus the cost of operation of all vehicles while using that particular road during the year.

A knowledge of all of the factors entering into this total cost is needed to furnish a basis, for equitable taxation of vehicles, for the proper lay-out of highway improvement programs, and for the economic design of the roads. In other words, the highway transportation cost is a dominant factor in the solution of all of the major highway problems.

In the case of heavy traffic roads the vehicle operating cost is the predominating factor. On very light traffic roads the roadway cost predominates.

If the vehicle owners are to be expected to pay a large part of the highway service bill, they should be taxed in proportion to the extent to which each uses the roads, and in proportion to the effect of his vehicle upon the annual cost of providing the highway. Methods for accurate determination of these factors depend upon further study of costs.

Vehicle operating costs are affected by grades, curvature, location and by the type of road surface. In planning an improvement program the type of improvement should be used for which the annual transportation cost will be the lowest at which the expected traffic can be adequately served.

In designing the road itself, consideration should be given to the effect of such features as grades, alignment, and cross section upon the total transportation cost. Knowledge of the effects of such features upon such items as gasoline and oil consumption, tractive resistance, and upon schedule speeds is needed for economic designing.

The principal elements upon which data are lacking in connection with roadway costs are the effects of quantity and kind of traffic upon maintenance costs, and the rate of depreciation and salvage value of various types of roads under various conditions.

More data are needed on all of the items of vehicle costs that are affected by mileage, for these are the items that are also affected by the roadway characteristics.

Research Needed.—1. Collection of data on relation of maintenance costs to traffic for all types of surfaces. Promotion of the use of uniform records of cost and traffic.

2. Collection of data on cost of resurfacing and on salvage value.

3. Study of rates of depreciation.

4. Collection of data on vehicle operating costs, especially on busses and trucks.

5. Study of factors, outside of vehicle design that effect operating costs.

(a) Road surface (tractive resistance).
(b) Grade and alignment.
(c) Tire wear.
(d) Car maintenance (mechanical depreciation).
(e) Cost of impediments to free flow of traffic.

How Shall the Road Be Designed to Give Adequate Service at the Least Cost?

Roadway.—Location, grades, alignment and width have a large effect upon transportation costs, traffic capacity and safety. Their effects upon vehicle costs are measured by tractive resistance, both rolling and wind resistance, fuel consumption, mileage, schedule speeds and traffic capacity. Their effects upon safety must be evaluated from accident statistics. Their effect on roadway costs, outside of construction, is measured by the cost of maintenance. The principal determining factors in establishing these features of a highway are quantity and kind of traffic and consideration of public safety. Too often the proper design indicated by study of these various factors will have to be modified on account of scarcity of funds. However, a knowledge of what is right will point the way to the use of what money there is to the best advantage.

The research needed to help evaluate these factors is largely a matter of effects upon transportation costs, and the principal items were listed under that heading.

Traffic—Effects on Design of Surface.—The effects of the quantity, kind and weight of traffic are the dominating factors in the design of the road surface since the only reason for building the road is to serve the vehicles that use it. The type of surface should be the one which will accommodate the expected traffic at the least transportation cost. For instance, a low cost road with high maintenance costs may be more economical for a light traffic road than a more expensive but more durable type, because in such a case the total saving in operating costs to the small number of vehicles using the road, by having a higher type road might not be large enough to overcome the high annual charge for interest due to the greater first cost of the high type road.

The physical effects of the traffic upon the surface are caused by speed, weight, and impact, and are ultimately measured in terms of cost of upkeep.

A difficult problem in each specific case is the deter-

mination of the controlling weight of traffic unit upon which to base the design. Information as to the frequency of use by the heavier vehicles is important.

Needed Research.—1. Wheel load intensities.

2. Distribution of wheel loads through various surfaces.

3. Effect of volume and weight of traffic on maintenance costs of various surface types.

4. Effect of speed on road surfaces.

Road Surface Types.—Road surfaces may be classified as high, intermediate and low type according to their suitability for heavy traffic main thoroughfares, medium traffic thoroughfares and community roads, and light traffic local roads. The principal problems in connection with all of them have to do with the development of the necessary characteristics to handle the traffic satisfactorily at minimum transportation cost. Much needed research has to do with materials for low cost intermediate types of roads. Development of road surfaces of this class will be largely a matter of experimentation in service. More detailed reports of these experiments should be made.

Needed Research.—1. Data on effects of weather and climate on various combinations of materials.

2. Data on effects of traffic.

3. Rate of wear of waterbound and traffic bound roads and effect of dust prevention measures thereon.

4. Salvage value of such surfaces in connection with change in highway types.

5. Critical study of various types of surfaces now in use.

6. Design of cross section for bituminous macadam.

7. Characteristics and methods of testing materials.

8. Data on relation between quantity and kind of traffic and maintenance costs.

9. Investigation of possible methods of stabilizing soil to form a road surface.

It is evident from this brief analysis that solution of the low cost road problem is dependent upon sound information on the cost of highway transportation, under a wide range of conditions, and that as yet many of the elements that go to make up the cost are very imperfectly understood. The only way to acquire this knowledge and to make it useful is by means of research, and that is why research is a large factor in solving the low cost road problem.

We have raised the money for state highway systems and have built durable and adequate roads thereon, but how to get money enough to build the vast mileage of serviceable, all year farm to market roads needed on the secondary systems and how to build such roads adequately on the limited funds that can be secured, are problems that challenge the best thought and professional skill of highway officials and engineers. The help of penetrating and thorough research work will be needed in the solution of these problems.

Each road should be improved to the extent that adequate service will be given to the users of that road at the lowest possible cost for the highway transportation. In the item of transportation cost must be included both the cost of vehicle operation and the cost of the roadway. A detailed analysis of this statement as applied to low cost roads would reveal innumerable questions for which we do not at the present time have exact answers, hence the need for research work.

Some of the major questions raised at once in considering such a program for road improvement are these:

(1) How is the money to be raised to pay for these roads?

(2) What will the roads and their use cost?

(3) What design of roadway and surfacing will serve the traffic adequately at the lowest cost?

It is not the purpose of this article to present answers to any of these questions, but merely to state some of the problems involved and call attention to the research needed for their solution.

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Special Unloading Conveyor Built by Road Superintendent

When John C. (Jack) Adams, superintendent for the Arenac County Road Commission, was put on the job of building the White's Beach and Timber Island roads in Standish township he believed that there was a swifter way of unloading gravel from cars than by sheer arm power of lifting heavy wet gravel over the high sides of the car or digging it out from underneath the car. After some concentrating he finally devised a plan that several state men have recommended to other county road commissions.

This new stunt of Jack's consists of a tractor, long steel cable and a discarded conveyor. The first act was the digging of a small pit under the tracks of the D. & M. switch at Pine River where the gravel was received. Then the conveyor was placed underneath the car in this pit. The bottom dumps of the car are opened and the gravel falls into the conveyor. Power furnished by an old motor starts the conveyor going and the gravel is hoisted into the truck which is backed under the high end of the conveyor. The trucks, with a capacity of one and one-half yards, are filled in one minute and 20 seconds. Before the truck is filled a second truck is backed against it and as the first one moves away the empty immediately takes its place. No time is lost and very little gravel falls to the ground.

To do this work there are two men in the car to keep the gravel in motion down the dump sides, one to level off the load on the truck, a fourth man to operate the tractor that moves the cars and also to do other work incidental to the task of loading or unloading, and three other helpers. In other words, seven men are enabled to unload six cars of gravel in five and one-half hours while the old system required 12 men to unload four cars in a full day. And the new method is much easier on the men and allows speedier construction of highways at a reduced cost.

Jack has received many fine compliments from various road builders and state road men on his new plan.—*Michigan Roads & Airports.*

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A Serviceable Township Road

Traffic-Bound Road of Washed Gravel in Roanoke Township, Ill.

BEFORE

Bridge on County Road East of Carrollton, Montgomery County, Ohio

Left—Old Castor Creek Bridge on Grayson-Dodson Road in Caldwell Parish, Louisiana

Above—Rickety Bridge Over Bayou Pierre in Natchitoches Paris, Louisiana

Left—Ferry on Bayou D'Arbonne, Farmersville-Bernice Road, Louisiana. Said to Be Shortest Ferry in the World

AFTER

Was Replaced by a 72-in. Culvert Which Is Too Short

Right—New Castor Creek Bridge Nearing Completion. Length Shortened by Fill

Above — New Bridge Over Bayou Pierre Is Stronger and Wider

Right—Ferry Replaced by Splendid Bridge on Same Location

The Township Highway Problem—II*

What It Is; Steps That Are Being Taken to Solve It; A Proposed Solution, and Recommendations for the Future; Conclusion of an Article from the July Issue

By GARRETT DAUNT O'CONNOR

Roy D. Chapin Fellow in Highway Engineering, University of Michigan, Ann Arbor, Mich.

THE writer finds that very little has been written on the subject of township highway administration. One of the few authentic articles is a dissertation by L. J. Rothgery, field engineer, Michigan State College, East Lansing, Mich., entitled "The Township Road Problem." He confines himself to the situation in the state of Michigan, which is typical of the middle western states. This article may be found in the *Proceedings* of the 1928 annual Michigan Conference on Highway Engineering.

Mr. Rothgery has been connected with township highway matters for several years, and bases his dissertation upon an intimate study of actual conditions. His statements may, therefore, be accepted as authoritative. The township highway problem has assumed national proportions, and is becoming a live topic amongst legislators.

R. V. Warren, formerly township engineer, Department of Highways, Commonwealth of Pennsylvania, has prepared an excellent report on the township highway problem in Pennsylvania. This report includes the only complete figures that have been received in response to letters sent to the highway departments of the 48 states. The complete report follows:

Pennsylvania has been wrestling with the township highway problem for over 15 years, and it is more to the forefront today than ever before. In Pennsylvania, there are approximately 75,285 miles of township highways in 1,512 townships of the second class. A township of the second class is the smallest political unit of government within the state. It represents the sparsely populated sections which have a population of less than 300 persons per square mile. Villages and hamlets are centered in some of these townships, but are not recognized as separate units of government. In each of the 67 counties, with the exception of Philadelphia, there are townships of the second class. The number of townships within the county ranges from 5 in Cameron County to 57 in Chester County.

The administration of the public affairs in these townships, with the exception of school matters, comes under the direction of township supervisors elected by the people of the township. Each supervisor is elected for a period of 6 years. Each two years one supervisor is elected; this provides for continuity in the township affairs. These officers have the same relation to their communities as a borough councilman has to his borough, except in most cases on a smaller scale. The principal duty in the average township is to see that the public highways are improved and kept in a passable condition. In some townships, however, there are the same public conveniences as in boroughs: fire protection, sewage works, playgrounds, lights on the highway, police protection and water service. These facilities are mostly in the villages and hamlets which are centered in the townships.

The township government unit is a taxable unit. The township supervisors have power to levy a tax of 10 mills each year on all taxable property for road purposes. An additional 10 mills may be levied with the consent of the court. In addition, separate levies are made for other purposes on the properties benefited.

Road work in the townships is generally handled by the township supervisors themselves. It is the practice of the three members of the board to divide the township into three districts, and each supervisor takes charge of one of the districts. In some townships, outside roadmasters are engaged to perform the work, and in others, the supervisors, as well as outside roadmasters, supervise the work. In cases where the supervisors and outside roadmasters are employed, the township is divided into five or more road divisions and each roadmaster supervises the work within that particular district. The receipts of the township are divided somewhat like the roads. Each particular roadmaster receives his proportionate share of the taxes collected. In most cases, the division is made on the basis of the number of miles of road in a particular district to the total number within the township.

Purchases of equipment for the maintenance and improvement of township roads is made by the board of township supervisors, subject to the approval of the department of highways. No contract for the purchase of equipment is valid without the department of highway's approval.

Townships of the second class are eligible to obtain financial aid from the state and from the county in which they are situated. Previous to the year 1919, there was in effect a plan known as the cash tax bonus plan. By this plan, townships were reimbursed by the commonwealth to the extent of 50 per cent of the taxes collected locally. There were no special requirements, in so far as road improvements were concerned, the grant being based entirely upon the tax revenue. The plan failed because of the inability of the commonwealth to meet its obligations and largely because the grant brought no direct improvement. In many cases, it tended to reduce the local taxation and failed to bring about any direct road improvement. In the year 1919, a new plan, known as the state reward plan, was provided. Under this plan, it is necessary for a board of township supervisors to make some improvement on a township road before the state's assistance is paid.

Under this plan the operations of improving a road are divided into three major operations—drainage, grading and surfacing. For each of these operations the commonwealth offers reward. For the drainage structures, payment is made on a 50 per cent basis. For the grading and the surfacing, payment by the commonwealth is made on a basis of 50 per cent of the cost, with a limitation on the maximum amount payable. In addition to this financial aid, the counties are privileged to extend county aid for the improvement of township roads, no limitation being placed on the amount. It may represent 1 per cent or 75 per cent. As a rule, the county's grant is one-fourth of the amount granted by the state. The county's grant, however, is subject to the approval of the state.

The department also furnishes the accounting forms that are used for the accounting of township affairs, minute books, warrant books, treasurer's account books and payroll forms are furnished free of cost to each township. Each year a new supply of these forms is forwarded.

The department of highways has had since the year 1913 a special unit which handled township matters. This unit is constantly enlarging, until today it has 30 field representatives. It is only within the last two or three years that definite steps have been taken toward solving the Pennsylvania township highway problem. Among other things, it is the aim of the department to reduce the administration in the local units to a minimum. Steps are now being taken to consolidate the position of secretary and treasurer, making this office a combined office to be filled by one person. This step is going to speed-up transactions and reduce the cost of government in some of the townships. An extensive drive is now being made in connection with township accounting. Each township in the state has been canvassed to learn how extensively the

*This paper, which was presented at a recent annual conference on highway engineering, held at the University of Michigan, is an abstract of Mr. O'Connor's fellowship report, which is on file in the Transportation Library of the university. The second portion of the paper will be presented next month.

department forms are being used and to obtain suggestions from the users for simplification of these forms.

During the past three years, we have been educating the township officials to the need of planning a definite system of township roads; a system that will contain primary roads, secondary roads, and will provide for the vacation of the useless roads. Township maps have been prepared for one-half of the townships, and in a few townships the supervisors have already selected the roads for the primary and secondary systems, and are taking steps to eliminate the useless roads. After this system has been planned in each township, it is the intention to limit the state's financial grant to the primary system, the commonwealth being privileged to withhold reward for the improvement made by the local officers, unless it is made on the primary system which has been approved by the department. Likewise it may be planned at a future date to extend aid toward the maintenance of the township primary system, both earth roads and improved roads.

A drive will be put on in the near future to curtail the purchase of township equipment. Department employees will advocate the purchase of road-building equipment by the commissioners in each county, and the rental of this machinery to the townships within the county at a nominal rate. This is now permissible under the present laws, but very few of the boards of county commissioners have taken up the plan, the chief objection being based upon inability of the commissioners to give all the townships the machinery when the officials of the township petitioned for it. This plan, however, can be worked successfully and it will permit of machinery being used throughout the major part of the year, while as it is now, township machinery is used less than one-third of the working days during any one calendar year.

The most successful plan of putting across the problem has been through the county meetings of township supervisors. Each year there is an annual meeting held at the county seat. All the supervisors, secretaries and township auditors are members of the organization and are entitled to attend these meetings, each being compensated at the rate of $2.50 for each day and 5 cents per mile. These meetings are all arranged by department employees, and the program is generally outlined by the department. At these meetings, department employees discuss the problems of the township supervisors and endeavor to put across the plans that are in the making for the advancement of the township work, such as the establishment of a system of township roads. In addition to the county associations, a state association has been organized, which meets annually. Each county association sends delegates, one delegate for each ten townships, or fraction, within a county. The department takes the same interest in the state meeting that it does in the county meeting, arranging for speakers, programs and other things necessary for successful conventions. At the state meetings, the discussion is largely made up of legislative matters. The proposed changes in the laws endorsed by the county associations are passed upon at the state meeting, and those finally approved are put before the legislature.

To date, the department has broken down a feeling of contempt which the supervisors once had against the department, and has built up a spirit of cooperation. At one time, township supervisors resented any suggestions from the department of highways; now, in almost all of the townships the supervisors seek the department's opinion before proceeding with their work. Moreover, the township officials are taking more interest in the management of township affairs.

The proposed system of township roads appears to be well accepted by the board of supervisors, and it is not anticipated that there will be much difficulty in putting across the idea in all townships when the department is in a position to furnish the necessary maps for each of the townships. The cooperative spirit runs all the way through the work. Many good suggestions have been received on accounting, and there seems to be a willingness on the part of the persons who will be charged with keeping the accounts to follow out the instructions of the department in the keeping of the township accounts.

Many miles of the township road have been improved under the reward plan, and many township bridges reconstructed. The improvements on the roads are largely made up of cinder, gravel, granulated slag and shale-surface roads, with a small mileage of macadam, surface-treated macadam and concrete roads in the wealthier townships. During the last six years, over 1,200 township bridges have been reconstructed with concrete, and today a larger number of the township bridges will support the maximum load permitted on Pennsylvania highways than ever before.

The department, by continuing its efforts and with the friendly cooperation of the supervisors, expects to provide many additional outlets from the farming communities. It is a tremendous task and a difficult problem to solve; however, yearly progress is being made.

Table II shows the need by the townships of financial aid. Throughout the state the average road fund available per mile is $186.29, raised by property taxes. This, of course, is supplemented by state aid, but the total funds have not been sufficient to provide surfaces on more than a few miles of road in the wealthier town-

TABLE II—STATISTICS OF TOWNSHIPS OF THE SECOND CLASS IN 66 COUNTIES OF PENNSYLVANIA

Number of Townships	County	Population	1927 Assessment	Mileage of Township Roads	Average Collection per Mile on 10-Mill Tax
21	Adams	22,958	$ 12,388,037	944.10	$131.21
29	Allegheny	54,465	76,861,163	884.21	869.27
28	Armstrong	46,171	34,810,652	1,663.40	209.27
24	Beaver	22,792	16,033,126	939.00	170.74
25	Bedford	26,619	13,927,014	1,636.70	85.11
41	Berks	61,678	45,622,292	2,133.62	213.82
14	Blair	36,729	16,427,104	576.20	285.09
38	Bradford	29,374	13,552,597	2,313.40	58.58
29	Bucks	45,235	36,429,419	1,592.10	228.81
32	Butler	34,114	24,611,740	1,623.80	151.56
29	Cambria	65,330	47,721,985	1,057.60	451.23
5	Cameron	2,783	911,725	106.30	85.70
10	Carbon	9,943	5,725,649	491.60	112.40
25	Centre	30,331	9,885,002	750.40	131.73
51	Chester	59,798	44,957,801	1,880.23	239.10
22	Clarion	25,117	8,003,570	1,219.10	65.65
28	Clearfield	64,961	11,388,704	1,350.30	85.08
19	Clinton	13,542	5,041,740	403.60	124.91
23	Columbia	21,756	9,765,344	1,052.97	92.74
35	Crawford	29,811	18,267,950	1,967.20	92.86
20	Cumberland	27,683	16,242,205	1,026.84	158.17
22	Dauphin	30,731	20,488,952	961.15	213.17
11	Delaware	14,203	13,683,243	223.85	611.22
10	Elk	16,577	3,460,931	406.50	85.14
21	Erie	37,360	24,823,343	1,431.10	173.45
23	Fayette	132,225	68,428,047	1,439.40	475.39
8	Forest	6,835	1,869,056	300.10	62.28
15	Franklin	34,339	21,392,330	1,037.62	206.17
11	Fulton	8,928	2,355,910	372.30	41.17
17	Greene	23,258	50,771,456	1,296.40	391.63
29	Huntingdon	21,795	11,221,428	1,130.10	99.29
24	Indiana	59,763	40,837,850	1,743.20	234.27
22	Jefferson	35,494	13,828,503	1,100.30	125.67
12	Juniata	11,552	3,245,204	603.50	53.77
16	Lackawanna	11,517	7,962,880	521.80	152.60
41	Lancaster	83,654	73,547,275	2,688.13	273.71
16	Lawrence	27,883	16,696,799	739.50	225.78
15	Lebanon	24,165	19,403,103	748.75	259.14
14	Lehigh	32,060	22,825,631	1,037.54	219.99
26	Luzerne	28,126	17,990,100	962.90	186.83
41	Lycoming	27,590	7,533,675	1,452.18	51.87
13	McKean	19,006	10,474,463	481.20	217.67
32	Mercer	29,713	16,672,173	1,503.50	110.28
10	Mifflin	17,945	7,799,040	449.52	137.50
16	Monroe	13,789	9,002,258	758.70	118.65
31	Montgomery	47,661	46,465,739	1,306.81	355.56
9	Montour	6,951	2,768,599	312.23	88.67
17	Northampton	30,193	21,215,959	967.50	219.28
21	Northumberl'd	18,446	8,498,009	884.04	96.12
21	Perry	14,779	7,143,591	909.20	78.57
11	Pike	4,515	5,541,188	476.30	116.33
24	Potter	11,824	3,106,297	930.36	34.03
21	Schuylkill	30,979	15,137,364	1,195.30	126.64
15	Snyder	13,683	8,432,223	640.10	131.73
25	Somerset	51,649	26,787,541	1,991.30	134.52
9	Sullivan	8,303	2,234,031	353.14	63.26
27	Susquehanna	17,536	12,584,911	1,646.31	76.44
29	Tioga	25,133	10,261,292	1,528.95	67.11
10	Union	10,281	6,269,098	426.36	147.03
21	Venango	22,009	13,118,851	1,002.10	130.91
23	Warren	20,970	9,868,501	971.30	101.60
33	Washington	78,324	92,485,908	1,989.80	464.80
19	Wayne	21,510	8,540,664	1,141.85	74.79
23	Westmoreland	137,781	79,663,114	2,516.80	308.58
18	Wyoming	9,821	3,612,481	634.00	56.97
34	York	57,387	29,201,998	2,402.60	121.54
1,454		2,122,442	$1,367,885,837	73,428.26	$186.29

ships. That the topography adds to the problem in Pennsylvania is proved by the fact that in six years 1,200 stream crossings in 1,512 townships were reconstructed in concrete.

[Since this study was made the Pennsylvania legislature passed a law transferring 20,000 miles of rural road to the control of the state highway department. —Ed.]

In conclusion, the township highway problem is "How to obtain hard-surfaced roads with inadequate road funds, inefficient methods of administration and construction and by a topheavy system of inexperienced elective organizations?" This situation, fortunately, is changing in some states, due to increasing state aid and control.

Attempts That Have Been Made to Solve the Problem.—In the state of Michigan an attempt has been made to help the townships through the public acts which have been passed from time to time. These attempts have not been very successful. Most of the roads improved under the state reward law have been embodied in federal, state or county systems. There were 50,000 miles of unimproved roads in Michigan when the motor vehicle began to be used for long-distance trips. A knowledge of their condition soon became general, and public opinion was aroused to the need of better roads. This is well shown by a few words from a paper by L. H. Neilsen[2]:

> Public opinion is demanding a better-kept surface on the public highways. The temper of the people is shown by the additional legislation passed at the last session of the legislature. The authority to pay 4 per cent of the state reward annually on all old roads that are well maintained shows the disposition to encourage and reward conscientious effort. In addition, drastic measures were authorized to be used where local authorities refuse or neglect to take the necessary steps to insure maintenance. Each local unit must submit to the state highway commissioner for approval an "adequate, efficient and continuous system of maintenance" before further state rewards may be paid for new construction. It is hoped that, through closer following up of maintenance matters and interchange of ideas, a material improvement can be effected in the general condition of the roads upon which state reward has been paid in the past.

That the need by the townships of state aid is fully recognized is evidenced by the following extract from a paper by Frank F. Rogers[3]:

> An act provides that the state shall assist the townships in the building of non-trunk-line bridges of more than 30 ft. clear span on a 50-50 basis, provided the township shall build not less than 3 miles of state aided roads, including the bridge. Eight bridges have been placed under construction by reason of this act. Realizing that no system of roads will last long or be at all satisfactory without an adequate system of maintenance, the legislature provided that a system of patrol maintenance shall be inaugurated in the townships of the state, covering not only the trunk lines but all state-aid roads. An engineer has been placed in charge of maintenance, and townships are being organized as rapidly as possible for this work.

The tendency towards centralization has become pronounced since the beginning of the present century. The advocates of local self-government are slowly falling in line with this movement. Townships and counties are cooperating.

The following quotation is from "Michigan's Roads and Taxes," by Frank F. Rogers, state highway commissioner of Michigan, presented at the eighth annual conference on Highway Engineering, held at the University of Michigan in 1922. (In the discussion on this paper, it was pointed out that several townships were cooperating with their counties in the construction of roads.)

> Originally, all the roads of this state were improved by the residents of the rural sections by statute labor and such moneys as were voted at the annual town meetings for such improvement as could not be handled without the expenditure of more or less real money. The legislature of 1907 abolished statute labor and provided for a cash tax for all road improvement with the townships. This tax, voted by the people at the annual town meeting, has always been the largest road tax levied in the state. In 1920, the township road taxes were over $11,000,000. The county road law first became operative in the early nineties. Every county in the state has voluntarily adopted the county road system. The county road law was responsible for the major part of the substantial road improvement of the state until the state highway department was formed. The county road taxes of 1920 were nearly $6,000,000.

Reports by county engineers at the 1924 and 1926 Michigan Conferences on Highway Engineering showed that the townships were beginning to see the advantage of cooperating with larger organizations. At the 1927 conference, Otto Hess described the work that Kent County is doing for the townships.

In 1912, John E. Brindley recommended that a road and bridge law should embrace the following fundamental principles:

1. The civil township should continue to be the unit of local government for the maintenance of secondary or township roads.
2. With a large amount of money raised annually by the townships for the maintenance of secondary roads, it is evident that an efficient plan of administration should be devised for the intelligent expenditure of this fund.
3. The county is a unit which supplies an important and necessary connecting link between the civil township and the state.
4. With the constantly increasing amount of taxes levied in the counties for road and bridge purposes, the necessity of having a trained county engineer, who should be an experienced road and bridge builder, becomes more and more apparent.
5. The present state highway commission should be granted larger powers and authority, and the appropriations for its support should be substantially increased.
6. Road improvement districts should be created for the construction of permanent roads, the cost to be apportioned equally, one-third to road improvement district, one-third to the county and one-third to the state.
7. All the motor-vehicle tax should be retained in the state treasury and used as a state-aid fund for maintaining highways.
8. The highway work should be placed on an efficient business basis, which can only be done by employing competent men and requiring that they give all their time to the work.
9. Finally, it is suggested that the supervision and control of public highways should be a township, county or state function, in proportion to the relative amount of tax levied for that purpose of those respective jurisdictions.

Reviewing these recommendations, one finds that the civil township continues to be the unit of local self-government for the maintenance of township roads, and will continue to maintain this status for a few years to come. The second recommendation is very pertinent. The county, as shown in this chapter, stands prepared to administer township highways efficiently. The need for county engineers has been admitted, and most of the counties now have qualified engineers in charge of roads and bridges. The various state highway commissions leave little to be desired; they are spending about as much as they could with the facilities and materials at their command. Road-improvement districts are found in many states and have been successful in improving roads. In some states, motor-vehicle taxes are still used for school and other purposes. Highway work has not yet been placed on an efficient business basis, but the terms, "savings to users," "income" and "anticipated earnings" are being heard in discussions of highway projects. The situation improves rapidly.

[2] "The State's Plan for the Supervision of Road Maintenance," by L. H. Neilsen, maintenance engineer, Michigan State Highway Department. *Proceedings* of the fourth annual Short Course in Highway Engineering, held at the University of Michigan in 1918.

[3] "Michigan's Roads, Progress in 1919 and the Outlook for 1920." by Frank F. Rogers, state highway commissioner of Michigan. *Proceedings* of the sixth annual Short Course in Highway Engineering, held at the University of Michigan in 1920.

In conclusion, Mr. Brindley has outlined certain principles, most of which have been accepted.

A Recommended State Highway Law.—In 1917, A. N. Johnson[4] published the results of a comprehensive research of highway legislation and summarized his recommended state highway law in these words:

> By way of summary, it may be said that the recommendations with respect to control are these: That a state highway department be established which shall have entire control of all roads toward which the state pays a portion of the cost, both as to their construction and maintenance; that in each county there shall be a county highway engineer, who shall be appointed by the county board, but who must possess the qualifications as outlined by the state highway commission, the rating of the candidates to be under the state civil service commission; that the county highway engineer's salary be paid from state funds and he be made subject to removal only on charges sustained by the state highway commission, and brought before the state civil service commission for determination; that the county highway engineer, under the general direction of the state highway commission, have charge of all road work in the county, other than those roads forming the state system, toward which the state pays a portion of the cost; that the roads over which the county highway commission is to exercise direct control be the county system, and that the county pay the cost in cooperation with smaller administrative units, either townships or road districts; that the county tax levy for highways be made by the county board on recommendations received from the county highway engineer as approved by the state highway commission; that in each small administrative unit of the county, whether township or road district forming a separate taxation unit, there be a road superintendent in direct charge of the road work, who, acting under the direct orders and control of the county highway engineer, would be continuously employed and have immediate charge of the local roads other than such as may be included in the state and county systems; that the tax levy for the maintenance of the local roads rest with the local board, which may or may not be instructed by the town meeting—in either event the rate to be made only on recommendation of the county highway engineer and to have the final approval of the county board; that no expenditure for work, either on the township system or the county system, be made except upon direct approval of the county highway engineer and in the case of the township system first having the approval of the town superintendent; that no expenditure is to be made for work upon the state system, whether such expenditure is paid in part or wholly from state funds, without the direct approval of the state highway engineer; that the township superintendent is to be appointed by the local governing board from candidates who have successfully passed the requirements as prescribed by the state highway commission; that he is to be paid from local funds and is to be removed only on charges sustained by the local governing board as finally approved by the county highway engineer; that there is to be money aid granted to local governing boards (the township or road district) from state funds which are to be withheld in case the local governing board does not carry out work in accordance with the rules and regulations of the state highway department acting through the county highway engineer.

Mr. Johnson's recommended state highway law was, of course, based on conditions prevailing in 1917. At that time, federal-aid legislation was bringing the states into line, and soon every state in the Union had a highway department. Most of the counties now have a county engineer, but they are not appointed on a civil service basis. However, the highway law of Illinois states:

> With the exception of the state highway engineer and the assistant state highway engineer, the appointment of all assistant agents or clerks or other employees of the state highway department shall be subject to the laws of this state relating to the civil service. The governor shall have the power to remove the state highway commission, engineer and assistant engineer for incompetence, neglect or malfeasance.

With regard to the counties, the manager or engineer-manager form of government has been adopted in some counties and is growing in popularity, but the state has no control over roads which are not being built entirely or in part out of state funds.

[4] Johnson, A. N. "Highway Laws of the United States."

The recommendation that each township have a full-time superintendent is sound, but unless the superintendent himself worked on the highways, few townships could afford to pay his salary.

In conclusion, a review of Mr. Johnson's proposed highway law impresses one with its brevity, simplicity and attention to the township highways. The chain of authority and responsibility is carried from the state department right down to the township superintendent. He senses the need by the townships for financial aid and the wisdom of administering the highway funds in an economical and efficient way.

Proposed Solution.—In proposing a solution for the township highway problem, the writer feels that the people who operate motor vehicles have created the problem and should shoulder the burden of its solution. When the townships were surveyed by the federal government, allowances were made at regular intervals for highways. These road allowances, as they are still called, were primarily to provide the farmer with a means of access to markets and centers of population. There must have been some thought of future needs, because the provision of a right-of-way 66 ft. wide, to enable a few farmers to occasionally drive to town or market, was absurd. Sixteen feet would have been sufficient. Fortunately, for present day demands of traffic, these 66-ft. rights-of-way were provided and thrown open to the public when required.

The farmers worked on the roads when required by statute or when they had time to spare or thought it necessary. There was no serious township highway problem until the motor vehicle came into general use. The problem varies with the different states, but in general it is the difficulty of providing hard-surfaced ways and maintaining them under destructive traffic. The lack of good surfaces on roadways has been brought to the attention of the public by the increased cruising radius of the motor vehicle. This phase of national activity is quite recent, and was caused by the sudden growth of a nation-wide system of service stations and a consequent development of touring to the status of an industry. During the last decade, large numbers of our people have taken to the roads as a means of transportation, recreation and education. Providing for the wants and needs of the tourist has become one of our leading industries.

The farmer has maintained the nation's highways for over 200 years, but now finds that he must have help. Efficient motor-vehicle operation depends more on a smooth, firm surface under the wheels than it does on straight, level roads. It is now generally understood and admitted that the persons who destroy road surfaces or want better surfaces should be made to pay for maintenance and new construction. It should not be necessary to add that, in order to obtain the best results from the township highway dollar, road funds must be administered economically and efficiently and road-building and maintenance placed in the hands of skilled or technically trained men. One-man control and centralization in industry has raised this nation into an enviable position among the great powers.

In 1922, Kirk H. Porter stated that the township organization was no longer necessary and predicted that it would die unless artificially stimulated. The township would be eliminated as centralization became more general.

But the township or town organization is still extant and functions in 23 states that contain 75 per cent of the population of continental United States. The public acts of Michigan, for instance, provide that township

highways may be placed under county control, and most of the 17 states which provide for organized townships also provide that these townships may disorganize or need not organize at all. In 1929, the writer finds that the typical township—and 20,000 of them are actually organized—has difficulty in maintaining its highways, and cannot afford the type of road surface desired by its taxpayers and the traveling public.

For all purposes, the township may well continue to administer its own funds, but state aid should be administered by the county as the agent of the state, which, with its own highway system, has all that it can efficiently handle.

State Aid and State Control.—The recommendation that the county be the smallest unit for administering highways is not new or recent. The majority of the states are organized on that basis at the present time. The writer believes that the best way to assure maintenance of all the township highways is to aid the townships financially and provide, in the public acts of the states, for county control for those townships which desire or need it. There are many townships that are so populous and wealthy that they can, and do, handle their road building better than some counties. The federal-aid legislation has been so positive in its action that one feels certain that state air on similar lines would solve the township highway problem with greater economy, less friction and a higher degree of satisfaction all around than any of the other suggestions in this report. Believing state control and state aid to be the best means of assuring adequate highways, the writer suggests that:

1. The highway law of the state should be codified under three main headings: (a) the highway system; (b) administration of highways; (c) the use of the highways by the public.
2. Highways should be classified only as state, county and township. The words primary, secondary, rural, country and suburban are confusing unless qualified as to location and importance.
3. Each mile of highway in the state should be included in the state, a county or a township highway system. Plans of these systems should be drawn and the plans revised, as each mile of highway removed from one system is embodied in another system.
4. The county system should be administered by a qualified highway engineer, appointed or dismissed by the county board or county manager with the approval of the state highway engineer.
5. The township system should be administered by a qualified highway engineer or superintendent, appointed or dismissed by the township board or township manager with the approval of the county engineer.
6. When a better surface is desired than that afforded by routine maintenance, road improvement districts should be formed. These should be administered by a qualified highway engineer or superintendent, appointed by the township board or township manager with the approval of the county engineer. When such districts are larger than a township, or include parts of two or more townships, the engineer or superintendent should be appointed by the county board or county manager with the approval of the state engineer. The cost of the improvement should be apportioned equally to the township or district, the county and the state.
7. No money should be spent on any highway in any highway system or road improvement district without the approval of the engineer or superintendent administering the same.
8. There should be three highway funds established in each state: (a) a state fund made up of federal aid, revenue from taxes on motor vehicle operation and revenue from taxes on property; (b) a county fund made up of state aid and revenue from taxes on property; (c) a township fund made up of state aid and revenue from taxes on property.
9. Construction and maintenance should always have in view the future requirements of the highway and its ultimate status as a township, county or state highway.
10. Provision should be made in the state highway law whereby townships could surrender control of their highways to the county, or contract with the county for construction or maintenance.

These suggestions apply only to those states in which the township is organized for the administration of highways. In submitting a proposed solution, the writer believes that he is interpreting correctly the trend of events. This solution makes it possible for the township to turn its highway problems over to the county, assures the highways of competent attention and induces closer cooperation between the state, county and township. In the opinion of the few writers on this subject, the county will ultimately become the smallest unit organized for administrative purposes, but this falling in line with a national trend towards centralization will take a number of years.

Traffic Volume at Variable Distances from the Center of Detroit

In order to show the greater need of street capacity nearer the center of the city, a study was made of five major trunk lines approaching the city of Detroit, Mich. Leroy C. Smith, engineer-manager, Wayne County Road Commission, in a paper presented to the recent highway conference at the University of Michigan, summarizes the results as given below:

The study covered the following trunk highways: Fort Road, Michigan Ave., Grand River Road and Gratiot Ave. Composite total traffic on these thoroughfares shows the following results:

50	miles	from center of city,	35,000	vehicles
40	miles	from center of city,	31,500	vehicles
30	miles	from center of city,	40,400	vehicles
20	miles	from center of city,	61,200	vehicles
10	miles	from center of city,	103,400	vehicles
5	miles	from center of city,	168,000	vehicles
4	miles	from center of city,	170,000	vehicles

These counts illustrate that the city's traffic influence runs out to approximately 40 miles. Beyond that point the influence of other cities exceeds that of Detroit. Further, the traffic is nearly three times greater at the 4-mile radius than at the 20-mile radius.

ARGENTINA TO BUILD TOLL ROADS.—The Argentine government has invited tenders for the construction of two toll roads, one from Buenos Aires to Rosario and Cordoba, and the other from the capital to Azul and Bahia Blanca, a total distance of 800 miles. The roads are to be 6 meters wide on a 12 meter right-of-way and must parallel existing roads. The concessionaries must render an annual statement, showing gross profits, operating expenses, etc., while the government undertakes to subsidize the company should the receipts be less than interest and amortization on the capital invested.

One good way of planning future construction and maintenance work was recently done by the county engineer of Mercer County, Penn., and a supervisor when they made an inspection of all the bridges of the county for the purpose of determining upon next year's budget.

The Road Builders' News

Detroit Meeting of County Officials' Division of the American Road Builders' Association Stresses Accounting

Accounting methods for counties that give a true picture of county finances was stressed in the meeting of the executive committee of the County Highway Officials' Division of the American Road Builders' Association in Detroit July 20th and 21st.

Detroit business men interested intensely in the coming 29th Annual Convention and Road Show in January, 1932, met with the committee and a number of Michigan county officials at a luncheon presided over by Edward W. Hines, commissioner for Wayne County, Michigan, for many years. The luncheon was held at the Book-Cadillac hotel, which will be the headquarters for the county highway officials during the Convention and Road Show.

G. C. Dillman, state highway commissioner of Michigan, welcomed the county officials to the state and told how the county and state highway authorities in Michigan had pooled their interests to obtain a complete highway service for the state.

Jas. H. MacDonald, treasurer of the American Road Builders' Association, gave his recollections of the first convention of the Association held at the Wayne hotel in Detroit in 1903 with only 40 present. He contrasted this beginning with the 25,000 present at conventions held in recent years in connection with the world's largest annual exhibitions of road and street equipment and material.

Fred Wardell of the Greater Detroit Committee offered full cooperation, and Harvey Campbell, secretary of the Detroit Chamber of Commerce, stated that Detroit as the center of the highway transportation industry was the logical center for the Road Show and Convention that did so much to provide highways on which motor vehicles operate.

"Like a snake swallowing itself," said Mr. Campbell, "the more automobiles, the more roads needed; the more roads, the more motor vehicles provided for. It is significant that the Convention and Road Show, which had its beginning in Detroit, should return to that city now the center of highway vehicle manufacturing.

"Motor vehicle taxes should be used for roads only," stated W. J. Connelly, president of the Michigan Good Roads Association, and a state senator responsible for legislation consolidating county and township highways in Michigan.

The excellent facilities for exhibits at the Detroit exposition building were told by J. E. Mills, commissioner of Public Works of Detroit, at the afternoon session presided over by Otto Hess, engineer-manager, Kent county, Michigan, and president of the County Highway Officials' Division.

J. L. Barrett, of the Detroit Convention Bureau, told of convention facilities; R. B. Holmes of the Michigan Central Railroad, told of rail facilities, and Preston Norton of the Hotel Men's Association discussed hotels for the January crowds of delegates. J. W. Hannen, owner of "Michigan Roads and Airports," extended press cooperation.

Committee reports were outlined for presentation at the January Convention and Road Show as follows:

Uniform accounting, purchasing equipment practices, specification forms, state aid extension methods, a county manual of planning, standard legislation enabling acts, aerial photographs, widening and reconstructing highways, surface treatment specifications and construction methods, and methods of promoting bond issues.

The executive committee was entertained by the Wayne County Highway Commission with a trip over the county system, and by Gar Wood with a trip in his speed boat and dinner at the Detroit Yacht Club.

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Road Show Held in Detroit This Year

Reports of more than a thousand leaders among road builders will be presented at the 1932 convention of the American Road Builders Association. The display of highway machinery, equipment and materials at the annual road show is unique in that few cities have auditoriums large enough to house the exhibit. The enormous Atlantic City Auditorium was filled to capacity with exhibits in the streets. The three St. Louis Arena buildings were jammed. At Detroit the Municipal Airport building, an enormous structure recently completed, will be filled with all kinds of displays.

The exhibit of motor freight equipment in St. Louis last year was perhaps the largest ever held. This enormous exhibit was made possible because of the large number of contractors and motor freight operators in attendance among the 25,000 road builders present.

Part of America's home is on auto wheels and a large part of the time of almost every American is spent in motor travel. Everyone demands safety, comfort and convenience in home life and the same demand is made for the home on automobile wheels. America's home on auto wheels is a cheerful home but the public that rides is the public that pays for the roads and that public wants good roads.

Self-evident as are the public profits and benefits of good roads, in some states attempts have been made to divert to other public uses the money paid by motor vehicle owners for the upkeep and improvement of roads. The public that uses the road—everyone—and the motor vehicle owners why pay the tolls in the form of taxes for the use of the roads would resent these legislative raids if they understood what was going on. Happily, little progress toward diversion of funds was made in the 42 legislatures that met this year. Legislators were wise enough to see the injustice and the political danger of tampering with tax money investments that are returning such high profits to the public.

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Road Builders Discuss Standardized Equipment

Manufacturers of equipment for road building and handling materials gathered on July 13 and 14 in Washington to discuss the standardization work of the American Road Builders' Association in effecting economies in the cost of building and maintaining roads and streets.

Low cost roads were discussed to effect standardization in the machines used, standardization of various machines and methods for handling cement for road construction, parts of snow plows, traffic devices, compaction of fills, blades for grading machines, rental rates on equipment were also considered.

The purpose of the discussion was to determine what details should be considered in the reports to be presented at the 29th annual convention and road show of the American Road Builders' Association in Detroit, January 11 to 15, 1932.

Some of the reports will be presented in cooperation with the American Association of State Highway Officials and the Highway Research Board at their annual meetings. Cooperative agreements with these organizations provide for representation of members of the American Road Builders' Association on the joint committees.

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The investigative work of the American Road Builders' Association is organized through committees of representative road builders aided by staff engineers of the association. Many valuable technical reports have been prepared and distributed by this association.

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A statistical service is maintained by the American Road Builders' Association that has recently collected advance information about state and county expenditures for the current year.

Tentative Program of the 1932 Road Builders' Convention

MONDAY, JANUARY 11TH: REGISTRATION

City—*Pavement Financing*
The portion of the cost of a pavement which should be borne by the general public in (a) Initial pavement (b) Repavement (c) Resurfacing.
Sources of revenue from which to pay the general public's portion of the cost.

County—*Administration and Finance*
Uniform Accounting (according to county classification).
Purchasing Equipment Practices.
General Requirements—Specification Forms.
Advertisement.
Invitation to Bidders.
Bidders' Bond.
General Information.
Contract.
Performance Bond.
Methods of State Aid Extension.

General—*Highway Location. Surveying Equipment. Highway Finance and Administration.*
County Highway Officials' Dinner.
City Officials' Dinner.
State Highway Officials' Dinner.

TUESDAY—JANUARY 12TH:

City—*Design and Construction*
Street Railway Track Pavement Design.
Contraction and Expansion in Pavement Bases.
Reinforcing of pavements, designed for residential area traffic, and which are now being required to carry traffic under which they cannot endure.

City—*Maintenance*
Surface Heater Work.
Low Cost Pavements.
Street Openings and Cuts.
Resurfacing.

County—*Public Relations*
Methods of Publicity for Bond Approval.
Regional Planning
County Manual Outlining Planning Procedure.
Standard Legislation Enabling Acts.
Aerial Photographs.

General—Recent Practical Developments in Design and Construction of Concrete Highways.
Recent Practical Developments in Design and Construction of Reinforced Concrete Pavements and Bases.
Bins, Batchers, and Equipment for Handling and Weighing Bulk Cement.
Recent Practical Developments in Design and Construction of Low Cost Road Surfaces.
Equipment for Construction and Maintenance of Low Cost Road Surfaces.
Recent Practical Developments in Design and Construction of Asphalt Pavements.

Motor Freight—Vehicle Tires and their Effect on Highways and vehicles.
Motor Freight Equipment.

WEDNESDAY—JANUARY 13TH:

Pan American — Translations into Spanish of Summarized Reports presented at other sessions.

City—*Traffic*
Safety Zones.
Traffic Circles and Multiple Intersections.
Radii of Curbs at Intersections.
Interpretation of the General Concept of Right-of-way as Applied to the Operation of Motor Vehicles in Traffic.
Re-routing of Traffic with Special Reference to Busses (1) Loading Zones (2) Bus Terminal (3) Relation of such terminals to central business district.
Building Safety Into Highways—or Reducing Accidents and Congestion by Proper Design.
Laning of Traffic.

County—*Design—Construction—Maintenance*
Widening and Reconstructing.
Surface Treatment Specifications.
1. Materials
Mineral or non-bituminous.
Bituminous.
2. Construction Methods.

General—Recent Practical Developments in Design and Construction of Brick Pavements.
Symposium on Recent Practical Developments in Design and Construction of Pipe Culverts.
Central and Truck Mixed Concrete.
Traffic Devices and Their Application.

Contractors—Standardization of Rental Rates for State-owned Equipment and Establishment of Relationship Between these Rentals and those Recommended for Privately-owned Equipment.
Street and Highway Maintenance by Contract (probably others).

THURSDAY—JANUARY 14TH:

City—Business Meeting.

County—Business Meeting.

General — Equipment for Spreading and Finishing Pavement Surfaces.
Recent Practical Developments in Design and Construction of Subgrades.
Compaction of Earth Fills as Effected by Type and Size of Haulage and other Equipment.
Symposium of Latest Practical Developments in Design and Construction of Low Cost Bridges.
Rock & Earth Excavation—Classification of Excavation.
Standardization of Shoes for Truck and Tractor Snow Plows.
Standardization of Blades for Truck Scrapers.

Traffic Delays Reduce Speed

Delay of traffic caused by congestion on highways leads some traffic officers to remark, "I could beat that procession on a bicycle," according to Maurice Eldridge, chairman of the traffic committee of the city officials' division of the American Road Builders' Association.

"On country roads the need for greater width to allow free passing is evident to every driver. The 3-lane roads with traffic traveling in the outside lanes and the center lane used only for passing permits high average speeds and under ordinary traffic conditions does away with processions of vehicles with a slow moving automobile in the lead.

"Some studies show that a 3-lane road has double the capacity of a 2-lane road."

Planning for 1932 Convention of Road Builders

In the foreground: James H. MacDonald, of Connecticut, treasurer of the American Road Builders' Association, and around the circle, to the left, Leroy C. Smith, manager of the Wayne County, Michigan, Road Commission; Otto Hess, engineer-manager of the Kent County, Michigan, Road Commission; H. A. Shuptrine, bridge engineer, of the Wayne County, Michigan, Commission; H. G. Sours, county engineer, Akron, O.; Charles Grubb, engineer executive, national association; W. O. Washington, county engineer, Brownsville, Tex.; J. W. Hannan, editor of Michigan Roads and Airports; James Burch, research engineer of the Wire Reinforcement Institute.

Meeting Held in Detroit, July 20 and 21, to Discuss County Activities

Road Builders Cooperate with Many Associations

The cooperative effort of the American Road Builders' Association in furthering studies leading to economy and efficiency in road and street activities on a joint committee basis with other associations has developed a number of interesting studies.

In addition to the recently announced studies of equipment problems in cooperation with the American Association of State Highway Officials, other projects have been begun by which recent practical developments in design and construction will be studied in cooperation with other organizations as follows:

Asphalt pavements, with the Asphalt Institute;

Brick pavements, with the National Paving Brick Manufacturers' Association;

Central and truck mixed concrete, with the National Ready Mixed Concrete Association, American Concrete Institute and American Society of Testing Materials;

Concrete pavements, with the Portland Cement Association;

Compaction of earth fills by various types and sizes of hauling and other equipment, with the National Research Council;

Low cost roads, with the Asphalt Institute and the tar industry.

The reports deal with the utilization of highway facts and will contain recommendations, conclusions and trends, a summary of application of findings, details of findings, and a bibliography.

Each report will be reviewed by a committee of specialists selected by the American Road Builders' Association after study by the staff engineers of the Association. After review by the committee the report will be prepared for presentation with important changes proposed by the committee, and resubmitted to the cooperating association.

The finally approved report will be presented by the committee chairman at the 29th Annual Convention and Road Show in Detroit, January 11-15, 1932.

The purpose of this cooperative work is to take up the lag between the discovery of new facts through research and application of such facts in road building.

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All Kinds of Roadbuilders Attend the Road Show

Every branch of roadbuilding is included in the attendance at the convention and road show of the American Road Builders' Association. When the event was held in St. Louis last year a study of the registration showed:

City Officials' Division.—There were present engineers, councilmen, commissioners, mayors, superintendents, clerks, treasurers, managers, assistant engineers, street supervisors—all employed by cities scattered from coast to coast in the United States.

County Highway Officials' Division.—County officials in attendance included engineers, inspectors, supervisors, superintendents, commissioners, judges, managers.

State Highway Officials.—Men engaged in work in all capacities were present from state highway departments throughout the country, commissioners, directors, chief engineers, assistant engineer, division engineers, superintendents, equipment engineers, resident engineers, patrolmen.

Contractors' Division.—Contractors in attendance included firms engaged in every class of work including grading, paving, draining, sewers, general construction, hauling, quarry, sand and gravel operators, superintendents, purchasing agents.

Consulting Engineers.—Consulting engineers were present representing specialties such as traffic, landscape work, city planning, parks, engineering teaching, the U. S. Bureau of Public Roads, commercial testing work, architects, railroads, editors of technical publications, structures, metallurgy.

Manufacturers and Distributors. — There were present officers, engineers, salesmen, managers and production officers representing the entire industry engaged in the manufacture and distribution of road and street machinery, equipment and materials.

Pan-American and European.—Honorary representatives of the association in other countries throughout the world, engineers, public officials, and experts attended the convention and road show.

Canadian.—There has always been a large attendance for Canada and men engaged in all types of roadbuilding were included among those present.

Students.—Students from engineering colleges in this country and abroad come to this annual event as the source of the latest and best information about methods, machines and materials for roads and streets.

Miscellaneous.—A small but interesting group of laymen interested in road building, journalists, bankers, equipment operators, mechanics, railroad officials and men engaged in many other types of work were present.

Judging by the attendance records of other conventions and road shows, the event at Detroit, the dynamic city and center of the motor industry, will bring to the exhibition and convention halls a total exceeding 25,000 road builders.

The exhibit of motor freight vehicles will undoubtedly exceed in size anything that has been held before. The attendance of motor freight operators will be the greatest ever.

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The export of highway materials and machinery to foreign countries where road programs are just beginning on a large scale will be a valuable addition to business, according to the American Road Builders' Association which maintains Pan-American and European divisions to acquaint foreign engineers with American methods.

Economy in Road Building And "Drive Safely" Clash

"Economy in roads and streets is brought about by reducing losses," states W. R. Smith, president of the American Road Builders' Association, in a recent interview on the status of road and street activities. "Economy is not merely a matter of reduced expenditures. On the contrary, reducing expenditures means increasing the losses under the present conditions of lack of safety and costly congestion on the highways.

"Estimates by the National Conference on Street and Highway Safety on the cost of congestion on the highways exceed two billion dollars annually—more than is being spent for road improvement and maintenance. The property damage due to vehicle accidents exceeds a billion dollars annually.

"The slogan of the day is 'Drive Safely,' which means drive with 'courtesy and caution.' But the high speed of modern automobile traffic makes safe roads a first essential of safe driving. The accident-prone driver is a double menace on sharp curves, narrow bridges and culverts and on roads built for safety at low speeds.

"The losses of poor roads are sometimes hidden but the total loss is tremendous. Everyone has lived in a section of poor roads. A road that is paved but has on it narrow bridges, sharp curves and is too narrow is not a good road. It is certainly not a safe road.

"Economy and increased safety do not go hand in hand if economy means reduced road facilities. Economy is the result of increased road building to bring the highways up to the point where they render satisfactory service for motor vehicles. The growth of motor vehicles both in number and speed has far outstripped the highway facilities of the United States. That is one of the reasons for the congestion, discomfort and danger of much of the motor vehicle driving.

"Losses of money due to lack of highway facilities can be eliminated in only one way," concluded Mr. Smith, "by improving highways until unsafe roads are eliminated and one can drive with comfort, speed and economy."

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Stage construction of unimproved city streets is advocated by a committee of the American Road Builders' Association. Under this procedure the dirt streets are graded so that the surface is at or below subgrade elevation for a pavement. Any material placed on the dirt street to make it firm may then be incorporated in the subbase of the pavement when built.

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The last annual road show of the American Road Builders' Association had nearly half of one of the buildings filled with motor trucks, probably the largest exhibit of motor trucks that has ever been held. The exhibit next year is expected to be still larger.

New Equipment and Materials

A New Clam Shell Digging Bucket

The new Type "N" clam shell bucket announced by the Jos. F. Kiesler Co., 938 W. Huron St., Chicago, is improved in design and construction, employing many of the well known Kiesler features to which have been added the redesigned powerful double fulcrum digging arms, shells, cutting edges and teeth.

A feature of this bucket is the correct design which enables it to penetrate freely

New Type "N" Kiesler Bucket

and dump sticky materials quickly. No obstructions on inside of shells. All parts built extra heavy for continuous service and long life. No dead weight built into the bucket.

Hughes-Keenan Iron Mule

A late model Hughes-Keenan Iron Mule with 4-yd. gravity dump body is shown in the illustration. This product is made by the Hughes-Keenan Co., Mansfield, O., and is supplied on McCormick-Deering Model 20 industrial tractor and also the Allis-Chalmers Model U industrial tractor, the same general construction applying to both. The body is gravity dump type with special latches holding it in loading position until released by driver and also the same latches automatically lock it in dumping position at nearly a 90 degree angle.

Body is 3-yd. capacity level with sides and easily handles 4 yd. with a heaped load. An unusually sturdy steel channel section frame supports the body with its

Hughes-Keenan Iron Mule

load and the Iron Mule mechanism, the tractor being hung in this frame and acting as a driving unit only. A special axle at radiator end, called the oscillating axle, allows the wheels to set at different elevations but always keeps them erect. This permits easy steering when running over very rough ground and also relieves all strain on tractor and Iron Mule frame.

At the drive end are special heavy duty crawler tracks which are mounted on an auxiliary axle which is rigidly connected to the Iron Mule frame by heavy steel castings. The tracks are driven through a pair of wide face special alloy steel cut gears on each side, one gear being attached to the drive axle, the other to the drive sprocket on the track and all gears are fully enclosed in a dust tight case and run in oil. This construction relieves the tractor of load strains and tractor is used as a driving unit only.

New Motor Sickle Highway Mower

A new motor sickle highway mower, stated to cut from 8 to 20 miles per hour, has been designed by the Rawls Manufacturing Co., Streator, Ill., for mowing along highways. Sickles are propelled with twin vee belt drive to Pitman wheel

New Rawls Motor Sickle Highway Mower

direct from 3-hp. gasoline engine which eliminates many expensive wearing parts, such as, gears, drive shafts, universal joints, brackets, etc., as the sickle speed is instantly and easily changed to any desired speed up to 1200 by means of convenient throttle control. Frame is of structural steel, reinforced, and welded. Wire wheels. Pneumatic tires. Tow hitch adjustable to different heights. Five or six foot cutter bar which will cut any angle straight up to 45 degrees downward. Has automatic spring trip whereas cutter bar swings back alongside of unit if obstruction is met, thus eliminating breakage. Has a cruising speed while not mowing up to 50 miles per hour over smooth surface roads.

This machine is entirely new and different from the traditional mowing machines, both in appearance and operation. It is developed and based on a quarter of a century of experience specializing in mowing machines and nothing else, in making them stand up under any kind of grief encountered in mowing vegetation from the arctic to the tropics.

Gasoline Powered Hammer

The Rodax Corporation of Chicago, Ill., has recently placed a new model on the market. This new design is 11 lb. lighter and weighs but 86 lb. However,

Two Cycle Gasoline Powered Hammer

this hammer has considerably more power than the former model.

The manufacturer has eliminated the oil cooling chamber with the horizontal and movable fins and air cooling the cylinder by a clever design which is air cooled with vertical fins. This is mentioning only a few of the many ingenious features appearing on this hammer.

Haiss Introduces New Stockpile Loader

The George Haiss Manufacturing Co., 141st St. and Canal Place, New York, N. Y., has designed a loader especially for average stockpile loading requirements—a powerful, high-speed machine which can be sold at very moderate cost.

Despite its popular price, the Haiss 50 is built with the same strength, precision and quality throughout, as are the large Haiss machines now in use. It has a capacity of from 1½ to 1¾ cu. yd. per minute handling materials in lumps not larger than 6 in. and weighing no more than 125 lb. per cu. ft. Driven by a 37 H.P. 4-cylinder engine equipped with intake air cleaner, oil filter, gasoline strainer and inbuilt governor, the Haiss Model 50 has the extra power which assures continued adherence to its rated capacity schedule.

It has an enclosed, roller and ball bearing, transmission with all gears and clutches running in oil. Another important feature is the feeding device, which consists of the patented manganese steel feeding propellers for which the larger

Haiss machines are well known. Manganese steel has been incorporated at many other points of wear so that the life of the machine is considerably lengthened.

There are only five controls, so that operating is especially easy. The truss

New Haiss Portable Bucket Loader

type boom is balanced on a pivot shaft and raised or lowered by a hand-wheel which operates worm-gear and jack-knife levers. The boom is self-locking in any position. High side guards and head enclosures minimize spillage and there is also a spillage pan to return material to loading point. There are tooth-edged, 12 x 18 seamless forged buckets.

The net weight of the loader is 13,600 lb. It is manufactured with every type of discharge equipment.

Aggregate Auto Gage

An aggregate auto gage has recently been announced by Toledo Precision Devices, Inc., a subsidiary of the Toledo Scale Co., Toledo, O., which it is claimed will:

Determine the specific gravity of concrete aggregates; determine the percent of moisture of concrete aggregates; compensate for surface moisture of concrete aggregates; show exact weight of dry aggregates; indicate the weight of regular run aggregates; show actual weight of surface moisture; make sieve analysis; show moisture within the aggregates themselves, and do regular weighing.

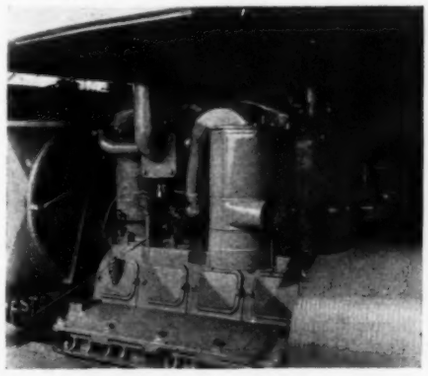
This device is designed primarily for production, laboratory and inspection work. It is claimed to insure correct water-cement ratio, correct proportion of cement to volume of concrete, uniformity of product, strength and durability.

Aggregate Auto Gage

Northwest Engineering Co. Develops New Advance in Carburetion

After many months of research and development work the engine laboratory of the Northwest Engineering Co., builders of gasoline, electric and oil powered shovels, cranes and draglines, has announced a new advance in carburetion.

This consists of a new modern type carburetor and hand idling control, claimed to be a distinct advance in this type of mechanism in a shovel or crane. Its use is stated to assure greater power particularly at low speeds in hard pulling. More responsive throttle opening. Steady operation at part throttle and gov-



Close-Up of Engine Showing New Method of Carburetion

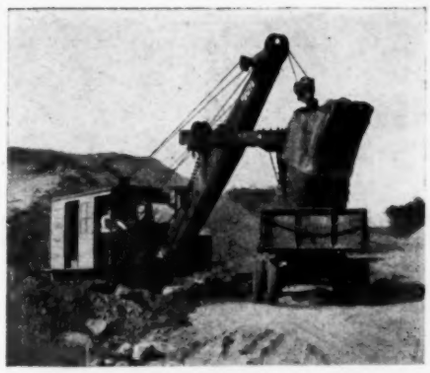
ernor idle speeds. And most of all better fuel economy.

For the present it is applied only to the larger engines on the Northwest line.

New 1-Yd. Bucyrus-Erie Shovel

A new 1-yd. convertible shovel-dragline-crane-clamshell has been brought out by Bucyrus-Erie Co., South Milwaukee, Wis. In this new 32-B special attention has been given to balancing the various motions—hoisting, crowding, swinging and dumping so as to secure a minimum time for the complete cycle. Stability, accessibility, quick convertibility and most efficient transmission of power to give maximum digging force at the dipper teeth are features of this machine.

Outstanding items of interest include choice of gasoline, Diesel or electric power, either rope or chain crowd on shovel, special extra long and wide mountings for soft ground dragline work. All continuously running shafts are mounted on ball bearings. Engine transmission gears are fully enclosed and run in oil as do also the boomhoist worm and gear and the reversing transmission



New 32-B, 1-Yd. Bucyrus-Erie Shovel

gears for swinging and propelling. So that there will be no binding of bearing there are only two bearings to a shaft. The transmission gears are silent with generated teeth, machine-cut from solid steel. There is an outside band power-take-off clutch and positive power dipper trip. The machine has a box girder boom and outside handles, single-shaft drive caterpillar mounting and an inserted tooth dipper.

The Austin Model 55 Shovel

The Austin Machinery Corporation of Muskegon, Mich., recently announced as an addition to its line the model 55 fully convertible shovel. This machine is equipped with a 50 hp. Waukesha gas engine, standard shovel boom 16 ft. 6 in. long, twin dipper stick 12 ft. long, and has a lifting capacity of 12,000 lb. Capacity is 11 cu. ft., struck measure—½-yd. working capacity.

Two shafts mounted in ball or roller bearings comprise the machinery unit in the upper frame. Only eight spur gears and five bevel gears are used in the construction. The lower frame is all cast steel, while the accurately machined cast steel upper frame assures perfect alignment of the machinery.

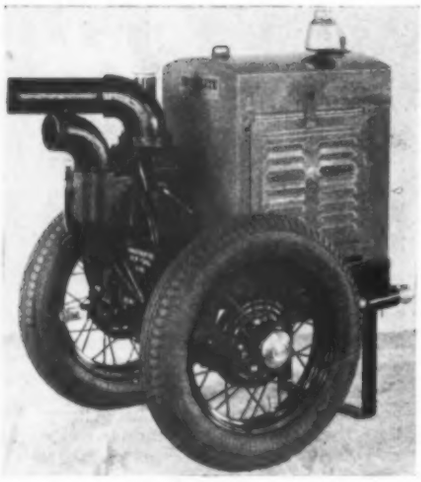
The important feature of the model 55 is the two-speed transmission built into the power take-off unit, which provides two speeds for all operations. Multi-

Austin Model 55

pedals are of the self-cleaning type with large idler rollers reducing the power required for tractioning.

The Homelite Portable Self-Priming Centrifugal Pump

The Homelite Corporation of Port Chester, N. Y., is now offering a portable self-priming centrifugal pump in 2 in. and 4 in. sizes. The pump is equipped with a 4-cylinder Le Roi engine, and comes mounted on steel wheels or pneumatically tired wheels for use as a high speed trailer. For convenient handling, the unit is supplied with a handle telescoping into the frame.

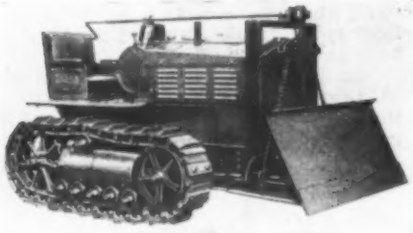


Homelite Portable Centrifugal Pumps

Heads up to 50 ft., with suction lift of 28 ft. can be handled. The unit is constantly self-priming without the use of an extra priming pump. No stuffing box is used, and the open type bronze impellor is capable of passing muddy water with solids. Pump and engine are a single unit constructed without the use of extra shafts, bearings, or couplings. Tests in actual use have given runs as high as 840 consecutive hours without failure. Weight of the complete unit is 730 lb.

Hall Bulldozer Mounted on Cletrac

A new combination of tractor-bulldozer is illustrated. This is the Hall mechanical lift bulldozer mounted on the Model 15 Cletrac of the Cleveland Tractor Co.,



Hall Bulldozer Mounted on Model 15 Cletrac

Cleveland, O. The bulldozer has a blade 53 in. wide by 24 in. high, made of ¼-in. plate. The cutting edge is ⅜ in. by 6 in. The push bars are 4-in. I-beams. The lift range above grade is 10 in. and below grade is 4 in. The raising rate is 1 in. per turn of hand crank.

New "Cub" Portable Loader Announced by Link-Belt

For many years Link-Belt Co., Philadelphia, Pa., has manufactured a portable loader called the "Cub." Although improvements have been made from time to time in this machine, Link-Belt Co. decided to recreate the "Cub" into an advanced type, super service portable loader.

The new "Cub" is lighter by 100 lb., but it is as strong and substantial as the previous model, and briefly has the following added features:

Belt: Link-Belt 18-in. wide service brand conveyor belt. (The "Cub" conveyor is 21-ft. centers.)

Idlers: All-metal troughing rolls with roller bearings.

Shaft bearings: All bronze bushed.

Head pulley: 9-in. diameter, and pulls without slipping.

Electric motor: Ball bearing type, and well protected.

Drive: Cut gears and a short chain drive.

Lubrication: Alemite throughout.

Safety first, raising and lowering device: A convenient crank operates a self-locking worm and wheel. Very easy to change height of conveyor to suit high or low trucks.

Sharp pointed nose at foot: An improved boot with belt guide to keep belt lined up.

Screen: A substantial, large-area screening chute is furnished for retail coal yard use.

Trough plates: For special purposes, hinged trough plates can be furnished.

Substantial channel frame: Has full length cover over return run of belt.

New "Cub" Portable Loader

Wheels: New type wheels are equipped with roller bearings, making for ease in shifting from place to place.

New 7-Yd. Crawler Wagon

The latest product of the Trackson Company, Milwaukee, Wis., is a complete 7-yd. crawler wagon.

This is a bottom-dump cart type wagon designed to meet the requirements of dirt-moving contractors. It weighs only 8800 lb. complete and is built entirely of steel, with special reinforcements at the points which are subject to greatest wear and strain. At the front and rear ends, for instance, are box-shaped, cast steel headers. Extra-heavy 8-in. pipe provides a straight, tubular tongue which is clamped between the two front header castings and thus practically becomes an integral part of the frame structure. The tongue leads at an angle direct from the front header of the wagon to the tractor drawbar.

A feature of the wagon is the complete enclosure of the drawbar spring in the end of the tubular tongue, entirely protected from dust and dirt. This spring is an assembly in itself and can be removed from the drawbar for repairs by simply removing two bolts. The drawbar head is provided with two holes, the lower for use in connecting direct with the tractor drawbar and the upper hole for connecting to another wagon ahead when several wagons are hauled tandem.

Without the flareboard, which may easily be removed or bolted on, the wagon has a loading height of 61½ in. A single lever is used for both dumping the load and winding up the doors. The doors are made of ⅜-in. steel plate, flanged and reinforced with angles. They are hinged on the inside of the body with flexible hinge connections which permit the doors to move forward if they come in contact with a stone or other solid object when in the dumped position. A cable equalizer keeps both doors shut tight.

The wagon is equipped with Trackson 15-ton Crawler Wheels.

New Trackson 7-Yd. Crawler Wagon with Trackson 15-Ton Crawler Wheels

New 110 Cu. Ft. Davey Portable Air Compressor, Ford Mounted and Powered

The latest development in Davey Air-Cooled portable air compressors is a 110 cu. ft. unit powered by the Ford Model "A" industrial motor, and mounted on a standard short wheelbase Ford truck chassis.

Using the Ford Model "A" industrial motor for the compressor power plant provides the advantage of interchangeability of parts between truck and compressor motor; and also makes available to the user motor service for both compressor and truck motors through the 35,000 Ford service stations, in cases where motor repairs or replacements are needed.

The Ford Model "A" industrial motor drives the Davey compressor through clutch and V-belts; the compressor unit is started by cranking the motor only. With motor running the compressor starts pumping air with a one-finger pull on the clutch lever. Electric starter is

New Ford Mounted and Powered Davey Air Compressor

supplied for the compressor motor on special order.

This 110 cu. ft. Davey Compressor unit can also be supplied on standard trailer mounting using the same Model "A" Ford motor, driving the compressor through clutch and V-belts. On trailer mounting total weight of compressor, engine and mounting approximates 2400 lb.

Longer Bodies for Federal Trucks

In answer to a growing demand for longer bodies on 1½-ton chassis, the Federal Motor Truck Co., Detroit, Mich., recently has developed two models with 168-in. and 163-in. wheelbases for the mounting of 11½-ft. and 12-ft. bodies.

Distributor News

Guy Frazee Killed in Automobile Accident

W. Guy Frazee, Vice President and Chief Engineer of the Iowa Manufacturing Co., Cedar Rapids, Ia., was killed in an automobile accident near Moose Lake, Minn., on Monday, July 20. His body was brought by plane from Moose Lake,

W. Guy Frazee

Tuesday afternoon, arriving in Cedar Rapids at 4 P. M. Dan Hunter piloted the ship in which were Howard Hall, President, and Kenneth Lindsay, Advertising Manager of the Iowa Manufacturing Co., both of whom had flown to Moose Lake Monday afternoon. The funeral services were held on Thursday.

Mr. Frazee had been with the Iowa Manufacturing Co. since its organization and had been interested in building road-working machinery for a number of years. He was connected with the Universal Crusher Co. before transferring to the new company.

He was born in Princeton, Ill., Nov. 2, 1891, and came to Cedar Rapids in 1908 with his parents. He was educated in the Cedar Rapids schools, was graduated from Washington high school, after which he was engaged in business except for two years spent in Clinton. He was married to Miss Leah Houser in 1913.

In addition to his widow and two children, W. Guy Frazee, Jr., 17 years old, and Nancy, 3 years old, he is survived by his mother, Mrs. Annor Frazee, 1274 Third avenue southeast, one brother, Gene Frazee of Marion, and five sisters, Mrs. C. H. Nelson, 1800 Seventh avenue southeast, Mrs. W. C. Ellis, 2334 Ridgeway drive southeast, Mrs. F. A. Keefer, 1823 Fifth avenue southeast, Mrs. Howard Lockwood of Ely, and Mrs. Ralph Gregg of Hawarden.

Ransome Concrete Machinery Co. Acquires Transit Mixer

The Ransome Concrete Machinery Co. of Dunellen, N. J., has acquired a controlling interest in Transit Mixers, Inc., and will hereafter manufacture at its plant in Dunellen, N. J., for that concern, its well known Transit mixers. Users of Transit mixers will, therefore, be given the benefit of Ransome's years of engineering and manufacturing experience in building concrete mixers.

This does not mean that there will be any change in the position or policy of the Ransome Concrete Machinery Co. in the field now occupied by it. The two companies will operate as distinctly separate units and there is no connection by the Ransome Concrete Machinery Co., by license agreement or otherwise, with any other concern in the truck mixer field.

Ransome's purpose in acquiring control of Transit Mixers, Inc., is to find employment for its capital and facilities in this new field, in which it has not heretofore competed, and to give users of Transit mixers Ransome quality, efficiency and service.

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Gardner-Denver Appoints New Representatives

The Gardner-Denver Co. has completed arrangements with the Hazard-Gould Co. of San Diego, Cal., whereby the Hazard-Gould Co. has the exclusive agency in the San Diego territory for all Gardner-Denver products, with the exception of the oil field steam and power pumps. Included in the products distributed by the Hazard-Gould Company are Gardner-Denver rock drills and Gardner-Denver portable compressors. These arrangements make available to the trade in San Diego County and for a distance of 100 miles south of the International line a more convenient source of supply of Gardner-Denver products.

The Texas Contractors Supply of Waco, Tex., will represent the Gardner-Denver Co. on all rock drill products and portable compressors.

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E. J. Mehren Elected President Portland Cement Association

By electing a president from outside the industry who will devote his whole time to the position, the Portland Cement Association, so the chairman of its board, Frank H. Smith, announced on July 20, has broken two precedents of long standing. Heretofore the leader of the Association has been a president of one of the portland cement manufacturing companies. During his term of office he has not only guided the work of the Association but has also continued to operate his own company. The duties of association president are so heavy, however, that the industry felt it unfair to continue to impose this burden upon the president of any one of its member companies.

Consequently, the Board of Directors has elected as president, Edward J. Mehren, vice-president of the McGraw-Hill Publishing Co. Mr. Mehren has been prominent in engineering and business circles through his participa-

Edward J. Mehren, President Portland Cement Association

tion in the work of engineering societies and business organizations.

He was editor for ten years of *Engineering Record* and *Engineering News-Record,* the leading publication of the construction industry. Later he became vice-president and editorial director of the McGraw-Hill Publishing Co., and latterly has been in charge of the company's activities in the Middle West, with headquarters at Chicago. He has been at various times a member of the executive committe of the New York Building Congress and father of its well known craftsmanship awards system; director of the American Road Builders Association, member of the committee on highways and motor transport of the U. S. Chamber of Commerce; chairman of the Marketing Problems Committee, Illinois Manufacturers Association. He is a member of the American Society of Civil Engineers, of the Western Society of Engineers, the University Club, New York; the Union League Club, Chicago. He is a graduate of Loyola University, Chicago, and of the University of Illinois. Mr. Mehren assumes his new office Sept. 1.

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Gardner-Denver Selects New Representative in Texas.—The Texas Contractors Supply Co. of Waco, Tex., will represent the Gardner-Denver Co. on all rock drill products and portable compressors.

Service Exchange
for Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives of their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Civil Engineer, located in California, desires to represent manufacturers of equipment and supplies. Is widely acquainted in western states and can furnish engineering and financial references.

Services of experienced engineer available. Formerly connected with state highway department, and well known manufacturers. Will consider proposition from manufacturer or distributor of highway construction equipment.

Sales engineer, experienced in earth-moving machinery, desires connection on salary or salary and commission basis. Wide acquaintance with machinery dealers, oil and gas industry, pipe-line contractors and material men. References.

Warehouse facilities for serving Pittsburgh territory. Would like to secure line of portable and stationary conveyors.

Wanted, agency for any type of building specialties or contractors' machinery except mixers. Twenty years' experience. Familiar with all types of contractors' machinery. Could act as sales manager for Atlantic coast line with dealers.

Distributor covering Wisconsin and Illinois territory wishes to add to present lines. Thoroughly familiar with bituminous materials and equipment for handling.

Distributor situated in Portland, Oregon, desires line of stationary diesel engines, from 75 to 150 hp., to serve western trade for driving rock crushers and industrial plants.

Wanted, line of street markers or other traffic equipment on exclusive basis by distributor covering New Jersey and New York territory.

Export manager for American manufacturer of road graders is in a position to handle an additional line of non-competing construction machinery, for manufacturer seeking foreign representation.

Manufacturer's representative situated in New York City, now handling pumping machinery, would like to take on two or three additional lines serving the same field as his present account.

Manufacturer's representative with 25 years' sales experience, conversant with all types of pumps and their field, desires agency for either New York or export territory or both.

Distributor situated in Virginia wishes to make connection to represent manufacturer of manganese crushing plates and jaw rock crushers.

Wanted, exclusive sales right for state of Mississippi for line of automatic or self-loading wheeled scraper.

Wanted, for Buffalo, Niagara frontier and western New York territory, a good power and heating boiler account.

Wanted, line of picks, sledges and crow bars, spades, shovels and similar implements by New Jersey broker, with warehouse facilities, contacting New York and New Jersey jobbers.

Representative in northwest desires to handle on commission basis line of road building and maintenance machinery, revolving scarpers, tractors, rotary snow plows and V-type push plows.

Distributor of building specialties covering territory within 100 mile radius from Chicago is equipped to represent additional lines.

Representatives Wanted

Manufacturer of crushing and screening plants wants a representative in Manila, Philippine Islands.

Manufacturer of grader wants dealers in west and east central states.

Manufacturer of a new tractor dump wagon has a number of desirable territories open. Full cooperation extended to distributors.

Manufacturers of ditching and trenching machines, to facilitate the laying of pipe lines has liberal proposition to offer dealers.

Manufacturer of metal traffic lane markers for pavements, has a number of desirable territories open. Write for their proposition.

Manufacturer of air compressors and contractors' tools has number of desirable territories open. Full cooperation will be extended to distributors.

Long established and well-known manufacturer of industrial locomotives wishes to make contacts with qualified distributors. Locomotive line includes steam, gasoline, gas-electric and oil-electric. Supported by national trade journal advertising.

Manufacturer of complete line street repair equipment, tar kettles, heaters, patching plants, torches, etc., has open territory in southeastern states and desires active distribution. Territory largely open from Virginia to gulf states, inclusive, also state of Oklahoma.

Eastern manufacturer of grade-rippers, scrapers and road hones has desirable territory open for distributors.

Distributor with large warehouse, show room and service facilities, desires two or three additional lines. Maintains large sales organization, covering New York, Vermont, Maine, Massachusetts and Connecticut.

Manufacturer of asphalt ingredient adaptable for use in the road or industrial field, is seeking representatives for desirable territory in various parts of the country.

California territory available for distributor wishing paving expansion joint account.

Good, unassigned territory available for distributors and manufacturer's representatives to handle paving expansion joint line.

Manufacturer of transverse testing machines desires to build up distribution organization in this country and abroad.

Several desirable states open. Wanted, distributing organizations covering entire states by manufacturer of mechanical spreader.

Territory open in several states for representatives to handle grade-rippers, mechanical plows.

Manufacturer of steel dump bodies and oil heaters seeking distribution points in west central and southern states, including Missouri, Kansas, Iowa, Nebraska, Colorado, Kentucky, Tennessee, Mississippi, Arkansas, Louisiana and western half of Illinois.

Attractive territory open in states south and west of Chicago by manufacturer of cut-to-length, easily-erected standardized steel highway bridges, for spans up to and including 40 ft. Product sells to highway commissioners and superintendents.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer of contractors and builders levels and transits is seeking district sales manager. Exclusive contract given. Excellent territory still available. Backed by national advertising.

Manufacturer of complete line of construction equipment, mixers, saw rigs, plaster and mortar mixers and pumps has an open territory in the state of Maine and is looking for an aggressive distributor to represent him there.

Manufacturer of patented luminous highway danger signs and signals is interested in securing aggressive representation in various parts of this country and Canada.

One of the leading manufacturers of surveying instruments in the United States is seeking responsible agents in all sections of the country. Instruments are nationally advertised in all leading engineering journals.

Manufacturer of patented highway and zone marking machine desires sales representatives who are acquainted with highway officials in their own state.